Architectural
CONCRETE

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Concrete Construction at Wright Field

(Official U. S. Army Air Corps Photos)

OR the past two years most of the building construction n America has been for war purposes. This construc-, like all other activities intensified by war needs—goods duction, agriculture, transportation, chemistry, and icine—has developed new technique which will be of t benefit to the nation in peacetime.

ne of the most interesting groups of new buildings ted for war use is located at Wright Field. What tran-es in these structures is not public information at this ; but it can be stated that for the most part these build- are unique in both design and construction, and that presented many problems aside from the pressing one etting them built in rapid time.

number of the new buildings at the field are of archi- ural concrete—a material which, due to its plasticity continuity, has presented particular advantages in the ution of the new and unusual structural forms required . And concrete has in this time of emergency offered additional advantage of saving large amounts of critical als ordinarily used in building construction.

There is a war on!" is an admonition which meant ral things at Wright Field during the height of its ex- sion period: eliminating frills and doodads, getting the t out of materials at hand, and getting the job done From the start of design to completion these projects d for close cooperation between Air Force Engineers their unusual requirements, the U. S. Engineers re- sible for the construction, and the several contractors. of their problems were complicated by labor shortages by the most abominable weather conditions in the history of the Middle West.

Most rapidly completed structures were the twin administration buildings which were rushed to completion to take care of the great influx of military and civilian personnel. These buildings are L-shaped, of identical design and differ only in the arrangement of wings. The long side of each building is 292x65 ft. and the short side is 227x49 ft. Main entrances face each other across a 160-ft. wide concrete-paved plaza.

The buildings are two story and full basement, with main floor level considerably above grade to permit natural illumination in basement areas. Exterior walls are concrete 10 in. thick and formed against rough-sawed boards to produce a vigorous horizontally-accented texture. Ends of formboards were staggered to eliminate continuous vertical joints. The cost of board formwork was most economical and since plywood at the time was difficult to obtain, board forms were the logical solution to the problem of getting the buildings erected. Board forms, however, were not unusual at Wright Field. They had been employed several years before in construction of a large torque stand building with such satisfactory results that board-formed texture has been greatly favored ever since.

Due to the need for completion of the buildings as soon as possible, construction on both of them went forward simultaneously. This prevented a desirable interchange of identical forms for identical portions of each building; but since wall areas do not vary greatly in detail, the forms were used over and over on each building after thorough cleaning and oiling.



Twin administration buildings at Wright Field are large L-shaped structures, two story and basement. Speed records were set in getting these buildings co boards. Only exterior finish treatment is a portland cement grout wash at entrances. J. Gordon Turnbull, Inc., of Cleveland, and Sverdrup & Parcel,

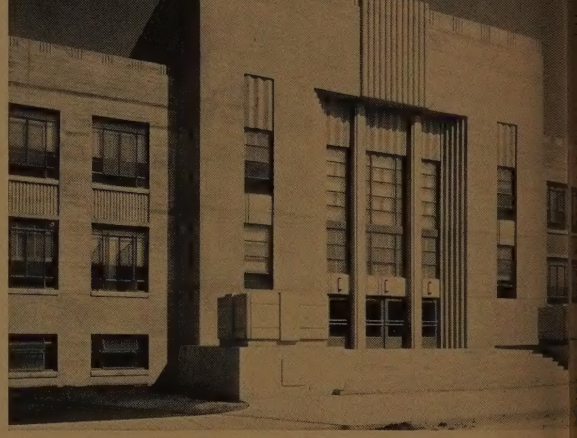
Architectural detail, confined primarily to entrance fluting, molded spandrels and dentil bands, was executed in wood molds, which were mill-run. The exterior, due to the time factor, was not given any finish treatment except at entrances where a grout wash of sand and grey and white portland cement was applied. It is doubtful that any paint will be applied, since time and use are expected to develop a natural patina that will harmonize quite properly with the board-formed texture.

Floor and roof construction is of the flat slab type, considered most economical for the intended loading in these buildings. Interior finish is largely lightweight concrete masonry, exposed and painted, with dark wainscots and lighter upper walls. The administration buildings were designed by J. Gordon Turnbull, Inc., of Cleveland, and Sverdrup & Parcel, of St. Louis, consulting engineers. Charles H. Shook, Inc., of Dayton, was the contractor.

The test laboratory building is in reality a group of four structures: a double hangar flanked by an operations annex on one side, a test office annex on the other, and a shops building to the rear. Only the hangars are not architectural concrete.

The operations and test office annex structures are rather similar in design except that the former has a 91-ft. tower and a two-story curved-wall operations room. The buildings themselves are two and three stories in height, formed with plywood and finished by the familiar grout clean-down method, and are not painted. Architectural design is modern with simple details in spandrels executed with wood molds.

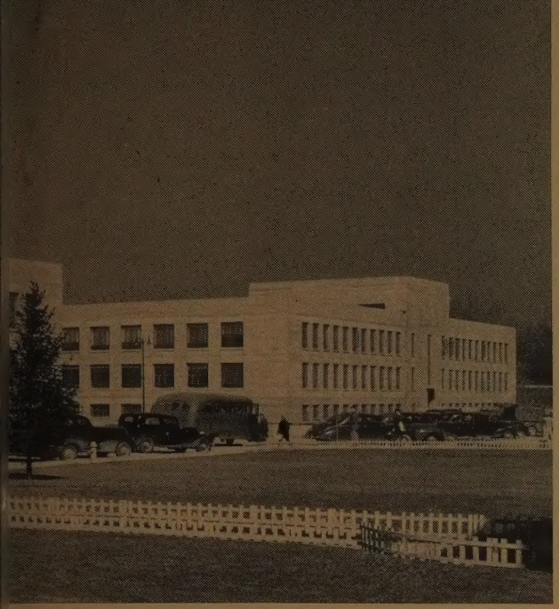
Exterior walls are 9 in. thick, cast in low lifts from window



Decorative detail is confined primarily to main entrances. The f made by use of mill-run wood molds.

sills to window heads at which points rustication lines a located. Forms were carefully built and aligned, and co crete supplied from a central batching plant set up on t field for this and other projects was thoroughly worked the forms. Most of the concrete was deposited by bugg and placing was assisted by careful application of hammers to the studs as well as by direct internal vibratio Concrete for the tower portion was lifted by elevator a then placed with buggies.

Both the operations and office buildings were under co struction at the same time, and a large part of the job w done during winter months. Normal protective measur



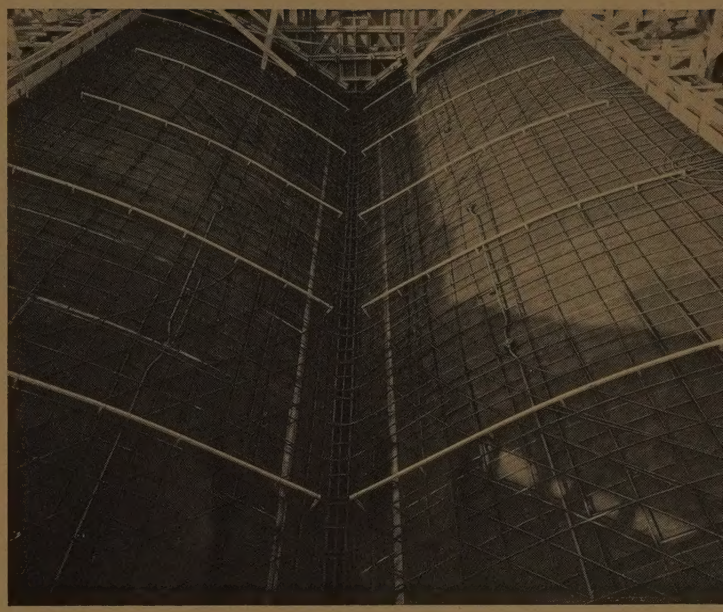
concrete with a texture obtained by use of rough-sawed form-ers. Charles H. Shook, Inc., contractor, of Dayton.

e taken in addition to the use of steam to protect against zing temperatures. Floors and roofs of both buildings of beam and slab construction.

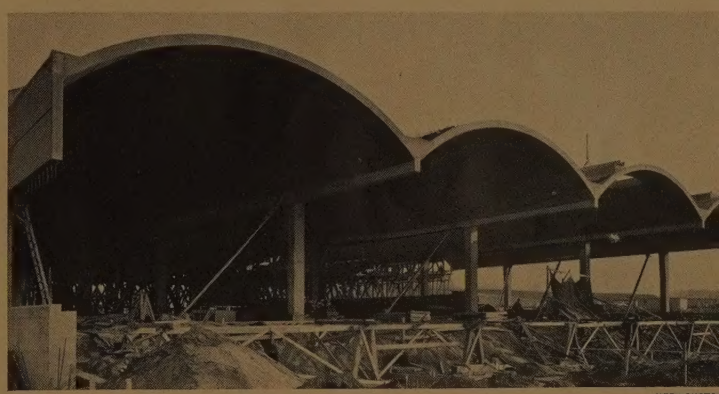
art of the exterior walls are painted directly on the crete as interior finish, while other parts are furred out finished with insulation board. Some partitions are tweight concrete masonry painted. Interior finish de-ded upon the type of use required in various areas. All ngs are insulated with acoustical material.

he engineering shops building, to the rear of the hangar, 60x420 ft. It is a single-story structure roofed over by ries of nine thin concrete barrel shells of 40-ft. span. barrels rest on columns spaced 56 ft. on centers. The that one part of the roof is higher than another (*see o, page 6*) and a section of the floor is 10 ft. lower than main floor complicated the construction problem.

he forming, placing of reinforcing steel, and placing of crete for these roof barrels were further complicated by numerous high curb skylights which were all placed ultaneously with the roof concrete.



Forms in place for barrel shell roof of engineering shops building. Relatively small reinforcing bars are required in the barrels of such roofs, thus effecting considerable saving in steel. Stiff concrete was compacted by vibration.



KEEN PHOTO

Columns, edge members and roof barrels were placed first, side and end walls formed later. Ends of barrels were cantilevered out from columns at expansion joints.

ring shops building after side and end walls were placed and the concrete was finished by portland cement grout clean-down. Roberts & Schaefer Co., of as consulting engineer.

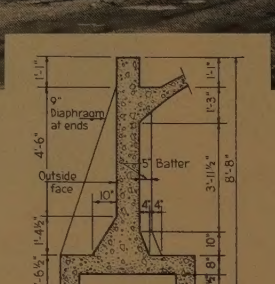


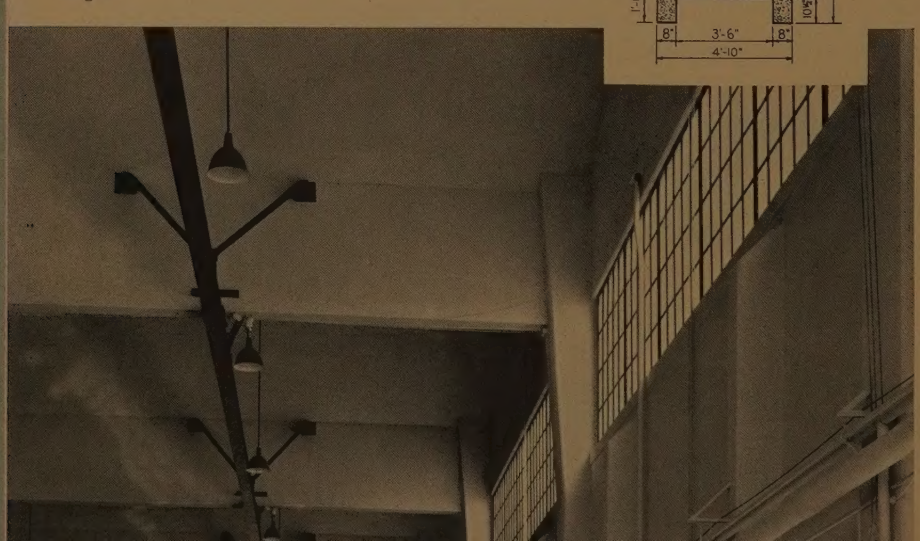


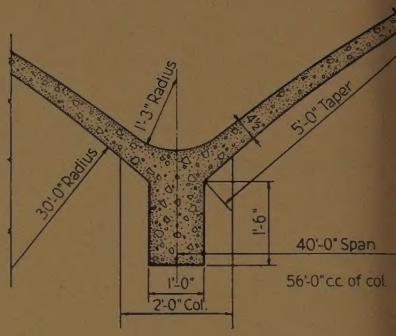
Interior of shops building showing variation in height of roof accomplished by raising falsework and forms on trestles. Curb skylight openings were cast with the barrels and glazed with sandblasted glass. Interior is painted white.

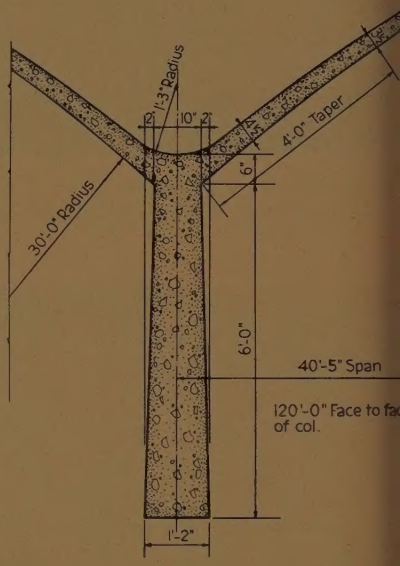


The same forms used on the shops building were used to form the roof of the Signal Corps hangar. In this structure, however, the barrels having no interior supports provide a clear span of 120 ft. Drawing shows detail of lintel over doorway. (Below) Interior view of roof of Signal Corps hangar.









Drawings show difference in depth of edge m bers for barrels supported on columns (abo and when used as cross barrels (below) for Sig Corps hangar. Designed by U. S. Engine Roberts & Schaefer Co., of Chicago, consult engineer; Simpson Construction Co., of Chica contractor.

Columns and roof barrels were c structed first and the side and end wa were added later, keys being left in columns to receive the walls. Barrel for were supported by falsework mounted small wheels rolling on a track of t widely spaced railroad rails and w moved from one end of the building to other. These forms were assembled one-eighth of the roof. The form sheathi was plywood bent to the curve of barrel and reinforcement was assembled illustrated in an accompanying pho graph. A stiff mix of concrete was used placing the shell which ranges in thickn

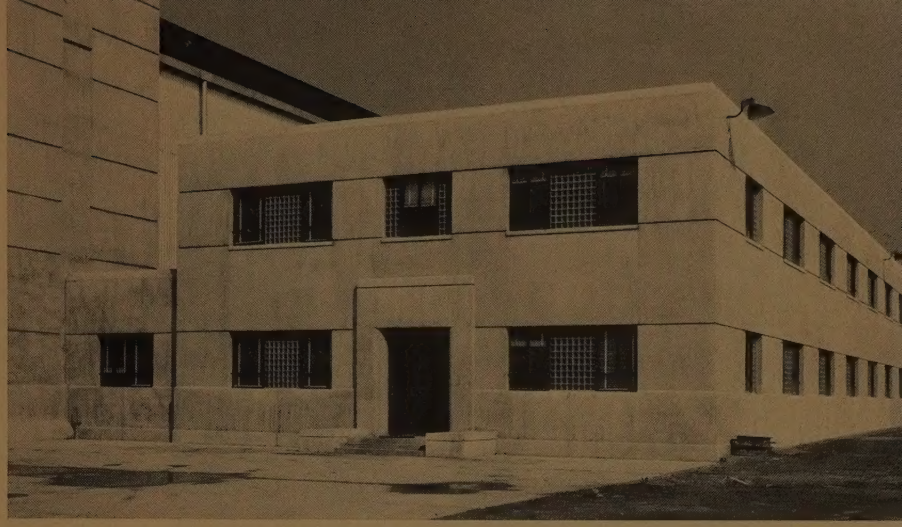
-5 in. at the haunch to 3½ in. at the
n. No top form was necessary. Con-
for the roof was compacted by direct
ation.

soon as each portion of barrel roof
placed and cured, forms and falsework
lowered and moved forward to the
position. The same forms were used
he part of the roof that is higher than
est. However, they were erected on a
le to provide additional height. Sky-
s are glazed with sandblasted glass to
ide even illumination with a mini-
n of shadows.

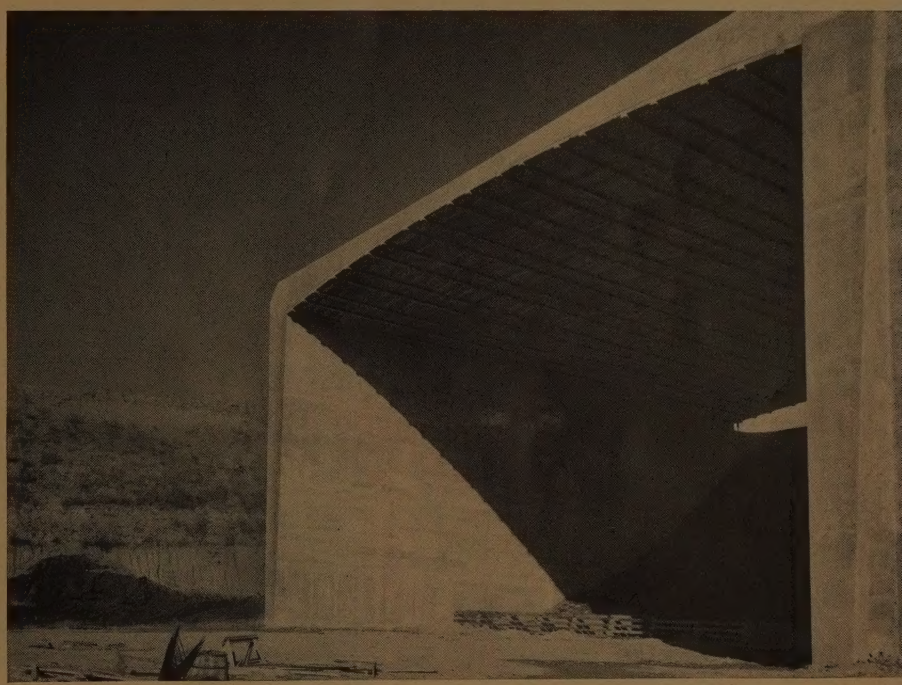
ne side and end walls were cast by
ns of form panels erected between the
mns. With roof and spandrels in place,
ob of placing concrete in the walls was
plicated because concrete could not be
ed from the top of the forms. This
culty was overcome by providing open-
in the outside of the forms through
h concrete was placed and vibrated
nally and by tapping on the studs.

alls were then cleaned down as were
perations and office annex structures.
ne laboratory test building group was
gned by the U. S. Engineers, Wright
d District, and built by National Con-
Fireproofing Co., Cleveland, Ohio.
erts & Schaefer Co., of Chicago, was
ulting engineer for the shops building.

daptability of barrel shell construction
arious types of buildings resulted in a
e measure of economy in the construc-
of the Signal Corps hangar. This
ding—a typical hangar with 120-ft.
—employs the shell construction as
barrels instead of longitudinal barrels
sed in the industrial-type engineering
s building. However, the same forms
were used on the shops building were employed here,
e their eight uses on that project left them in excellent
e. Due to the added height of the hangar, however, the
work had to be raised on trestles. The forms were
ed from one side of the building to the other as work
gressed. Construction procedure was similar to that on
shops building except that the hangar cross barrels,
ng no interior columns, have deeper edge members
orted on flared columns in the side walls.
xterior walls of the hangar were formed against ply-



One of two identical architectural concrete structures forming part of the armament laboratory. Plywood forms were used, after which the concrete was rubbed, and finished with portland cement paint. Designed by U. S. Engineers and built by Frank Messer & Sons, Inc., of Cincinnati.



An adjunct of the armament laboratory is this cover for a firing range. It is a rigid frame concrete structure with ribs on the outside to provide unobstructed interior. Span is 96 ft., height 65 ft.

wood, and the finish surface was obtained by cleaning with a grout mixture of part white and part grey portland cement applied with brushes and then rubbed off to uniform color.

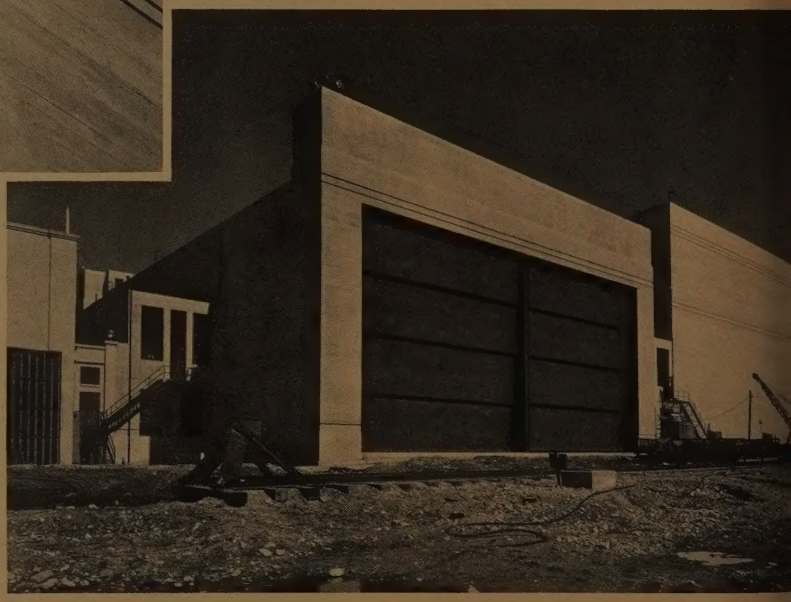
Roberts & Schaefer Co. was consulting engineer for this project, and Simpson Construction Co., Chicago, was the contractor.

Still another use for the barrel forms is contemplated at Wright Field where another project of this type is under way.

An armament laboratory group comprises a hangar



Rough-sawed board textures came into vogue at Wright Field with the construction of the torque stand building above. The same texture was used on the addition to this building —shown at right. Both structures were built by Simpson Construction Co., of Chicago.



which is not concrete and two end structures of architectural concrete which are two stories high and 52x202 ft. in plan. An adjunct of this layout is a rigid frame concrete cover for a 500-yd. firing range.

Features of the two end structures which are identical are simplicity of line, smooth-formed walls and portland cement paint finish. The walls were rubbed after forms were stripped and loose material was washed off before two coats of portland cement paint were applied. The interior is furred with wood strips and finished with insulation board.

Windows in this structure are double-sashed to exclude noise, and additional sound control is effected by the use of acoustic ceiling material. In erecting the walls, plywood forms were used and sills for ground floor openings were formed with the walls. Sills in the second story were cast after the walls. Floors are beam and slab construction.

The rigid frame cover for the firing range has the frame on the outside of walls and deck to provide an unobstructed interior. Span of the cover is 96 ft. and it is 65 ft. high from footings to the underside of the deck. Oak ties are bolted to the ceiling slabs.

The armament laboratory group of which the firing range is a part was designed by the U. S. Engineers and built by Frank Messer & Sons, Inc., of Cincinnati.

Father of all the rough-sawed, square-edged, board-marked textures at Wright Field is the engine torque stand building. To relieve the broad plain areas of this building boards of varying widths were used as form sheathing, and grain marks and joint lines were permitted to remain strong in the walls. It was found that construction joints concealed themselves in this type of wall texture without any special device such as rustications or V-joints. But what appealed most to the builders at Wright Field was the appearance of the walls, the strong shadow lines which give impressive feeling of mass and an excellent indication of scale.

An addition to the original engine torque building is a horizontal structure instead of the vertical U-type. It, too, has board-formed walls. The original stand was designed by the Constructing Quartermaster Corps and the addition by the U. S. Engineers at the field. Both structures were erected by Simpson Construction Co., of Chicago.

One of the most interesting forming jobs at the field was the major problem in the construction of the propeller test torque stands. This structure comprises four cells in groups of two with control rooms separated from the cell units by

orting their slab floors on brackets provided on the cell
s. Steel and lead plate bearings permit the cell walls to
e independently of the control room portion.

he two-cell units, each 95x169x60 ft., are designed as
l frames and are similar to huge double-box culverts.
ls are 20 to 22 in. thick and the roof is inverted beam
slab construction to provide a smooth ceiling. The
ire of each cell is a transition section from a 45-ft. square
42-ft. circle and back to a 45-ft. square. These are
ably the largest Venturi sections ever designed and
t, and presented tremendous problems in form detail-
form construction, and concrete handling. Construc-
photos included here will give some impression of the
lems involved.

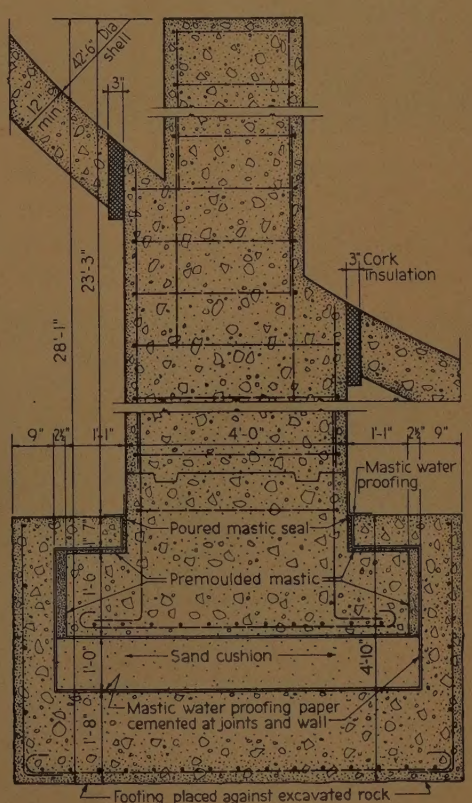
he upper forms on the lower one-half of these circular
ons had to be especially well anchored down to pre-
sly placed concrete in order to counteract the tremen-
s pressure or uplift resulting from the concrete being
ated into place.

ibs supporting the circular section forms were cut out
x12 boards shaped to each section which is a segment
circle. At the points where the section changed from
re to circular, the slopes were not steep and no top form



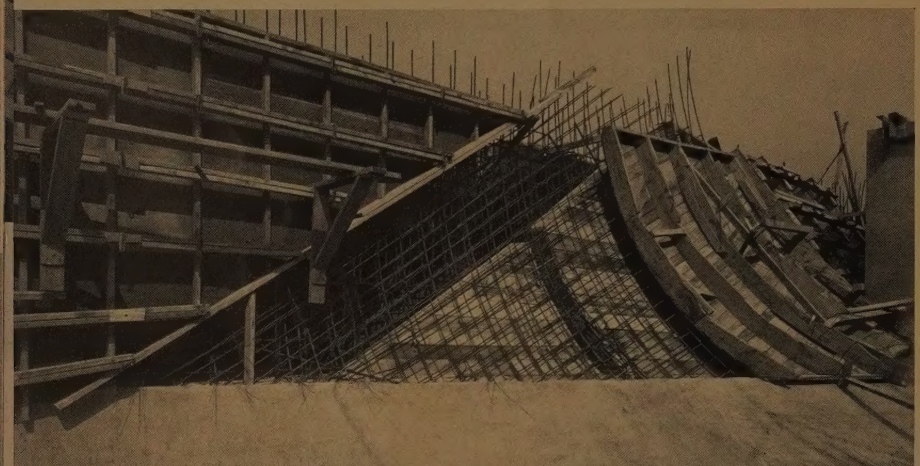
rque stands comprise four units in groups of two. In each unit is a tion with a transition from a 45-ft. square section to a 42-ft. roat. Figure of man standing on test platform gives some im- immense size of structures. Drawing shows detail of test blocks, independent footings down to solid rock so that vibration cannot red to main structure.





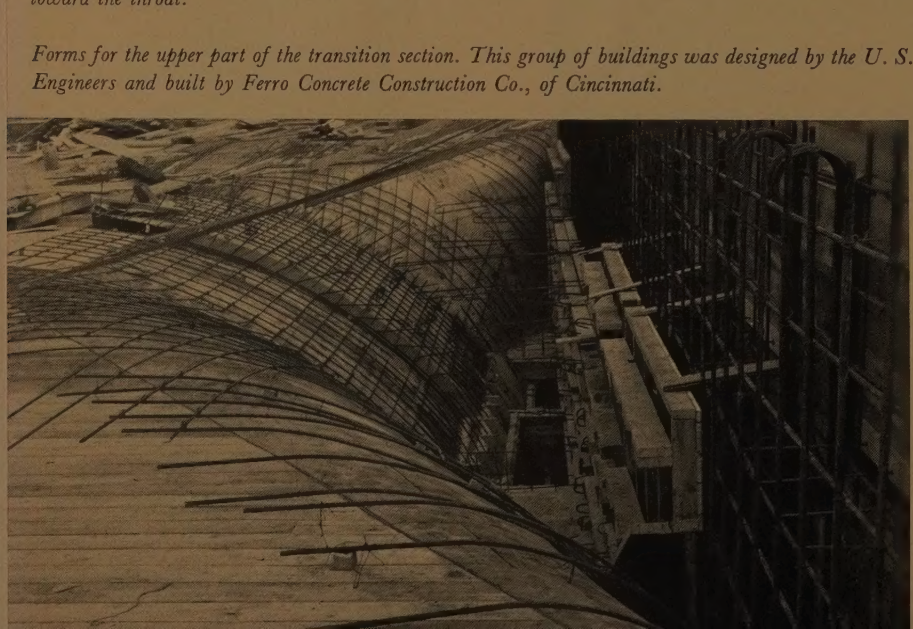


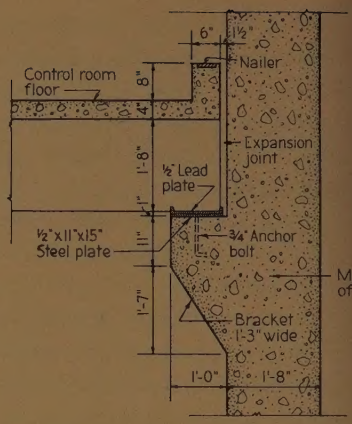
Lower forms being erected for transition section. Ribs were made of 2x12 boards cut to proper radius. Walls of the circular section are 12 in. thick. Building walls are 22 in. thick.



Lower part of curved transition wall in place with forms and reinforcing assembled for concreting toward the throat.

Forms for the upper part of the transition section. This group of buildings was designed by the U. S. Engineers and built by Ferro Concrete Construction Co., of Cincinnati.





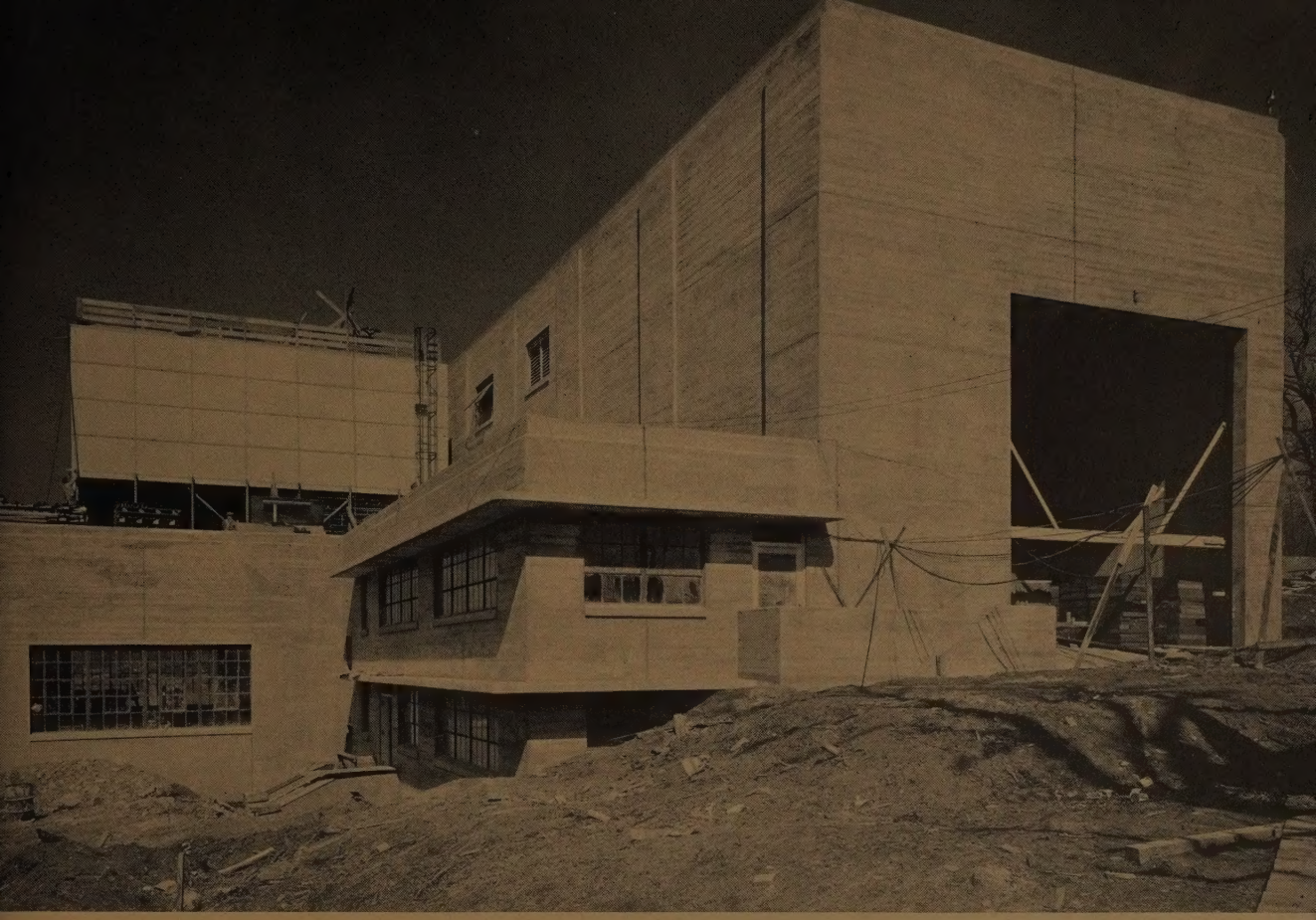
Details showing walls and slab of propeller torq building control rooms supported on brackets fr main walls. Steel and lead plate bearings perm control rooms and main structure to move ind pendently.

was necessary. A stiff concrete was used. A the curves approached the vertical, doub forms were employed and concrete with maximum slump of 3 in. was vibrated the forms to achieve thorough compactio Concrete walls of the circular section a 12 in. thick.

In each of the 42-ft. ring sections a three test blocks of streamlined, teardr design. They are independent of the ri section of the cell unit, being carried dow on separate footings to rock and insulate or cushioned all around with 3-in. thi pressed granulated cork set in hot aspha Impact and vibration of these blocks therefore, not transmitted to the rest the structure.

An exhaust tunnel 20x16 ft. runs unde neath the full length of the stands—abo 212 ft. This tunnel is a concrete box plac in an excavation made in solid rock.

Walls of the propeller torque units a board-formed using 6-, 8-, 10-, and 12-i boards with random arrangement of t different widths. Each width, however, w carried completely around the walls, there is no staggered vertical jointing. T boards are dressed on one side with t rough surface against the concrete. T walls were finished by brushing off loo material and washing with water. Desig of these units was made by the U. S. E



at openings in ground story of cold chamber building are located in the corners below windows and in the middle of the bay above windows. In the trol joints are concealed in the reentrant angle of the pilasters. Rough-sawed boards were used to achieve the interesting texture. This building was d time during bitter cold weather. Salamanders were lifted on cables within the building to heat freshly-placed concrete in high walls. Designed by nbull, Inc., and Sverdrup & Parcel, consulting engineers. Frank Messer & Sons, Inc., contractor.

eers at Wright Field. Ferro Concrete Construction ., of Cincinnati, was the contractor.

An interesting project from architectural, structural d construction standpoints is the cold chamber for nd tunnel No. 2. This building includes a large test- area, office and control room space and a refrigerat- unit. It is L-shaped with one wing 62x122 ft. and the ond wing 60x59 ft. Excellent board-marked texture, t-in-place canopies over office window areas, and ssive high walls give pleasing appearance.

There is an interesting and rather unusual arrange- nt of control joints on this structure. Instead of carry- control joints through the middle of ground-level ndow bays, the control joint above the window is ated in the center, while those below the window are ated in the window corners or jamb lines. The reason hat greatest tendency to crack is from first story to und and that the critical location for possible crack- is at window corners.

n the high walls, control joints are located in the in- e corners of the pilasters which are used to stiffen the walls. They are thus concealed, but function perfectly.

To prevent water from running back under the canopies and staining the wall underneath, drip-grooves were molded on the underside of the canopies near the outer edge.

Square-edge boards, 1x6 and 1x8, rough-sawed and sized for thickness, were used as exterior forms. Six to eight uses were made of these form boards and it is the conviction of the contractor that boards so used should be rough-sawed on both sides instead of surfaced on one side. Surfacing reduces the strength of boards, making forms more difficult to keep in alignment after many uses.

Cost of material, erection and removal of rough-board sheathing was no more than for plywood on this project, and finishing cost was considered to be about half that of the smooth-formed walls.

The cold chamber building was started about October 15, 1942 and completed about January 10, 1943, during which time the worst possible weather conditions for concreting were encountered. In spite of this, the work proceeded with dispatch and with excellent craftsmanship.

Materials were heated and forms were covered with tarpaulins when temperatures flirted with zero as they did on numerous occasions. Rain and snow made work difficult, but operations were never permitted to relax for any reason. Salamanders were lifted by cables on the inside of the building to the level of freshly-placed concrete in high walls.

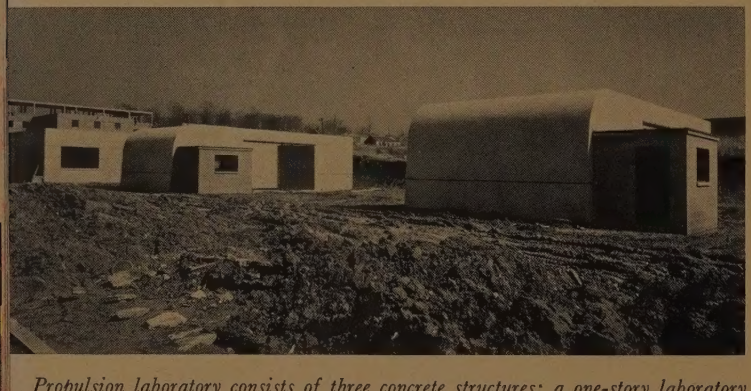
The structure was designed by J. Gordon Turnbull, Inc., of Cleveland, and Sverdrup & Parcel, of St. Louis, consulting engineers. Frank Messer & Sons, Inc., of Cincinnati, was the contractor.

The propeller laboratory building is part two and part three stories and basement. It is 98x277 ft. Wall thickness is 18 in. with basement walls 19½ in. Double sash is provided to eliminate noise, and office and laboratory portions are acoustically treated. The two-story portion is air-conditioned and has fixed windows.

Walls were formed against plywood and well-designed concrete mix was carefully placed to produce excellent surfaces. Two curtains of reinforcement were used in the thick walls—⅝-in. round bars at 12-in. centers. Control joints are located in the center of window bays at 20-ft. intervals in the first story and above at 60-ft. intervals.

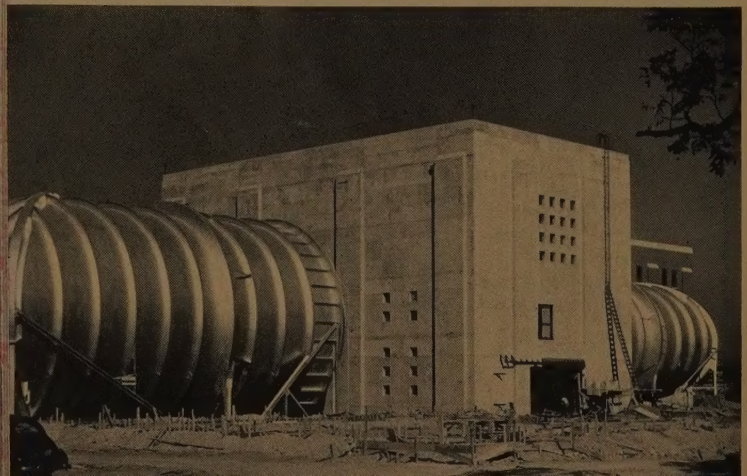


Main facade of propeller laboratory, a part two- and part three-s ing. The two-story section is air-conditioned, with fixed windo are 18 in. thick, double-sashed to eliminate noise from the outs are designed for 250 and 500 p.s.f. Designed by U. S. Engineer by Ferro Concrete Construction Co., Cincinnati.



Propulsion laboratory consists of three concrete structures: a one-story laboratory at left and two test cells, the latter having parabolic curved ends. The control rooms for test cells are built of lightweight concrete masonry. This group was designed by Rial T. Parrish, architect, and built by F. X. Minnigan, both of Dayton.

One of the earlier concrete buildings at Wright Field—a wind tunnel structure designed by the Constructing Quartermaster Corps and built by National Concrete Fireproofing Co. Walls formed against plywood and finished with a cement grout.



Floors of this building were designed for 250 and 500 p.s.f. Large portions of interior corridor walls and partitions are lightweight concrete masonry finished with portland cement paint. Outside walls were given a grout cleaning. The propeller laboratory was designed by the U. S. Engineers at Wright Field and built by Ferro Concrete Construction Co.

A modern group of small structures comprise the jet thrust propulsion laboratory. Main structure is 54x91 ft. and one story high. The two test cells are 22x51 ft. with 12- and 18-in. walls. The ends of the cell structures are heavy parabolic sections. Control rooms of the test cells are built of concrete masonry. Rial T. Parrish, of Dayton, was architect-engineer for this group, which was built by F. X. Minnigan, of Dayton.

An older structure at the Field, wind tunnel building No. 1, was designed by the Constructing Quartermaster Corps and built by National Concrete Fireproofing Co., of Cleveland. This building has smooth plywood-formed walls with cement-grout clean-down wall finish.

Other buildings of architectural concrete at Wright Field, not illustrated here, include an instrument test building 41x121 ft., one story high. The interesting feature of this structure was construction of 8-in. walls with two curtains of reinforcing steel in somewhat high lifts. This work was accomplished successfully by careful form construction and design of the mix for extra workability. A high cylindrical-shaped structure for testing parachutes is now under construction, and other architectural concrete buildings are being designed for erection soon.

New Wind Tunnels for the Navy

By Boyd S. Brooks*

(*Official U. S. Navy Photos*)

THE David W. Taylor Model Basin is expanding in personnel, equipment and apparatus, and in buildings fired to conduct the testing and research work for which establishment was planned and built.

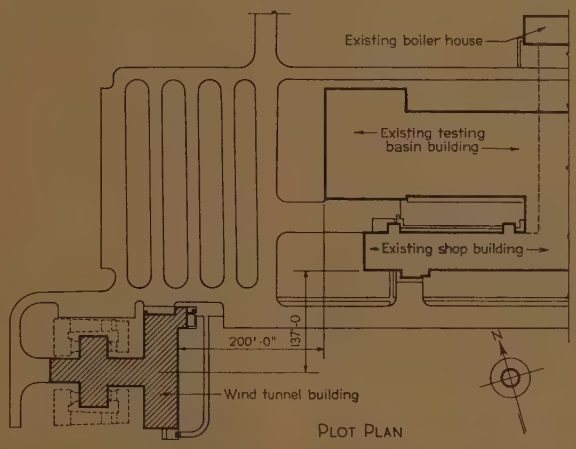
largest recent addition on this naval reservation near hington, D. C., is a wind tunnel building located to the h of the parking lot and west of the shop-office-laboratory building group described in Architectural Concrete, 6, No. 1.

has been definitely established that the first large-wind tunnel in the United States was built in 1912 at Washington Navy Yard under the direction of Rear Admiral David W. Taylor, then in charge of the Experimental Model Basin which was built at the Navy Yard in 1898. Thus model basins and wind tunnels have always been closely associated in navy experimental work, since both have to do with the making and testing of models which, though of different types and designed to operate in different media, follow rather parallel lines.

General specifications for the new building and tunnels were outlined by the Taylor Model Basin of the Bureau of Ships, and the Aerodynamical Laboratory of the Bureau of Aeronautics. Contract plans were drawn and specifications were written by the Design Section of the Bureau of Yards and Docks.

The wind tunnel building was designed to harmonize with the main buildings in detail and in construction materials.

st addition to testing facili-at the Navy's David W. or Model Basin at Carde- Md., is this wind tunnel ing. The unit in the fore- d—for offices and shops— uctural concrete faced with in. precast exposed-aggregate ete panels. The testing room e rear is of cast-in-place architectural concrete, formed against plywood and painted to match the panel walls. The new building is located apart from the existing buildings but close enough to utilize the facilities of the entire Model Basin establishment. Note how the tunnels enter the testing room where the actual testing work is carried on.



PLOT PLAN



*tenant commander, Civil Engineer Corps, USNR. All state- s or assertions contained herein are the personal opinions of the r and are not to be construed as official or as representing the ons of the naval service at large.



As in previous construction at the basin, the exposed-aggregate panels were used as exterior forms for the concrete. Trees removed from the area to r

However, in designing it, care was taken to keep it subordinate to the main group. The tower of the new building was located on the prolongation of the centerline of the road passing in front of and parallel to the main buildings. The lines are simple, for the building encloses industrial activities—shops on the first floor of the main wing, offices on the second floor, and a large testing room at the rear with a wind tunnel on each side.

To match the main buildings the front wing of the new building has exterior panels of precast exposed-aggregate concrete. As in the earlier buildings, the precast panels were used as exterior forms for the structural concrete walls. For the sake of economy, the connecting section between the front wing and the main testing room, the testing room and the one-story room at the rear, have exposed cast-in-place concrete walls. By carefully selecting the color of the portland cement paint, the line of separation between the exposed-aggregate surface of the precast slabs and the painted concrete walls is quite inconspicuous.

The exposed-aggregate panels are 2½ in. thick, reinforced with wire mesh which was dipped into hot coal tar pitch to avoid possible rusting. The rear 1½ in. of the panels, or the backing, is a mixture of pea gravel, bank sand and grey portland cement. The 1-in. exposed surface of the panel is made with specially-graded white quartz aggregates and white portland cement. Steel anchor straps were bent around and welded to the wire mesh reinforcing for use in supporting the panels as outside forms and to tie them into the structural concrete.

The panels were erected with a regular stone-setting derrick, the largest panels being 5 ft. 2 in. by 12 ft. They

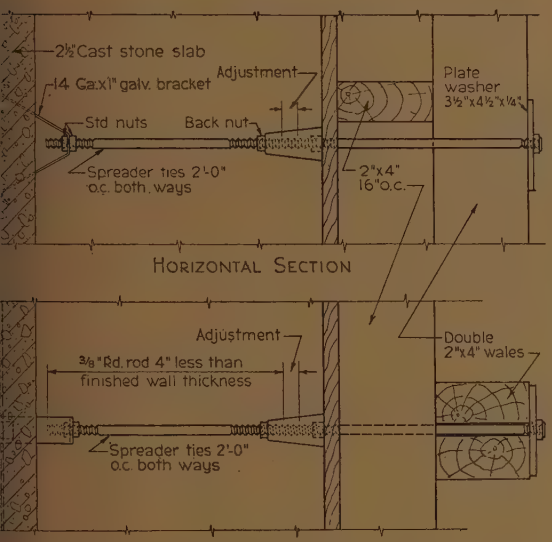


Close-up of wall panels in place. Texture was obtained by brushin cement paste from quartz aggregate surface and cleaning panel with acid. Joints were sealed against water on the inside and care fully pointed after structural wall concrete was placed.

were held in place by steel bolts fastened to the ancho straps by a nut on each side of the strap. The other end o the bolt was threaded and attached to a cone provided t act as a spacer for the inside forms. An additional bol threaded into the base of the cone extended through th wales supporting the inside form. With the exterior precas slabs and the inside plywood forms erected and the rein forcement in place, concreting proceeded in the usual way for concrete walls.



ll be replanted and the entire area landscaped.



pical sections showing method of tying cast stone used as outside l form to plywood inside form.



Main entrance tower is located on the centerline of the roadway which parallels the main buildings at the Model Basin. The tower offers a pleasing contrast of plain wall and window areas. Note large precast panels.

Wind tunnel building under construction (below). In foreground precast panels are being erected by derrick. When walls were partially erected portions of the steel wind tunnels were brought to the site and erected on concrete piers.



An economy in precast panel forms was effected by making up a master form for each type of panel and by placing concrete in the largest forms of each type first. The forms were then reduced to the next size, until the last and smallest size was cast. This permitted considerable reuse of forming materials and avoided the usual large number of forms necessary when panels of varying sizes are required.

One of the interesting features of this project was the use of cantilever precast canopies over the windows. These L-shaped units, cast in lengths to correspond with adjacent wall slabs, were erected with the slabs and secured in the same manner. On the front portion of the building these canopy units have exposed-aggregate texture.



An interesting feature on this building is the use of precast cantilevered canopies over windows. They are L-shaped units, arranged with the wall panels as part of the exterior forms.

After the slabs were in place, joints were filled at the back to a depth of ½ in. with a calking compound forced in under pressure to prevent water from the newly placed structural concrete from escaping through the joints. All joints were finally pointed and given a beaded finish as indicated in the close-up photograph of panels in place.



Where the plain concrete walls and exposed-aggregate panels meet. Plywood-formed walls at left were given a finish of portland cement paint to match the color of precast panels at right. Even at a short distance the difference between these wall surfaces is inconspicuous.

Concrete for the walls of the rear units of the building was cast in the usual plywood forms. This work proceeded at about the same rate as that on the front unit.

Unlike the main buildings of the previous group, which are rigid frame structures, the tunnel building has conventional beam and column framing with two-way slab floors and roof. To avoid disturbance from vibration within the structure and to prevent settlement, foundations for both the building and the tunnels were carried down to solid rock. Each tunnel rests on 12 concrete piers and is held in place by a total of 112 bolts. It was found desirable to drill holes in the piers and grout the bolts in place rather than place the bolts at the time of concreting.

In order to make room for the new building, a number of trees were removed from the site. These will be replanted later around the new building by station labor. There are also two raised planting areas near the doorways of the building—one at the main entrance tower and one at the side entrance. The shrubbery to be placed in these two raised areas is intended to relieve the plain walls and to accent the entrances.

Work on this building was started about February 1, 1942, under the direction and supervision of the Resident Officer-in-Charge, Bureau of Yards and Docks Contracts, and it was turned over to the Navy January 29, 1943.

Architectural Concrete Work on the Pentagon Building

By F. E. Ross*

HE War Department's Pentagon Building, recently completed across the Potomac from the national capital, he world's largest office structure. It derives its name n its mighty five-sided shape. It contains more than 0,000 sq.ft. of floor space can shelter the population town of 40,000. The five rs of the building are hed by ramps and corri-s. There are no elevators the five escalators are for ted use only.

The building is reinforced crete and, except for the r walls, the concrete is ex-ed. This was a bold step in v of the fact that architec-l concrete has been used y to a limited extent in this nity. But it is now felt that lts shown on this huge ject will justify further con-ration of exposed concrete future buildings in the shington area.

There are some 1,113,000 t. of exterior concrete walls in the five sections of the lding plus an additional 58,000 sq.ft. in the sewage dis-al plant and the powerhouse-refrigerator unit. This ludes the walls of the inner court, the eight additional ring ls of each of the five sections, the walls of the inner-court rways, and the bridge passageways between the five gs of each section. In addition there is considerable archi-tural concrete in the approaches to the mall and terrace.



Close-up of typical wall texture produced by rough-sawed boards with chamfered edges. Sharp, clean molding of the grain marks indicates good control of concrete mix and careful handling in the forms.

For all exposed concrete walls the architect specified a texture produced by rough-sawed board forms. Horizontal lines were accented by making a bead at each board joint. The texture and beaded joint were produced by using modified shiplap form lumber, rough-sawed on one side and chamfered along the face edges.

To give the walls a uniform color and texture, an on-and-off grout treatment was applied by the concrete finishers. Wet grout was brushed on the walls with even strokes parallel to the grain marks. As the grout reached a certain degree of set, it was removed with burlap and brushes, leaving the color of the cement-sand grout. A deposit of sand with the particular qualities desired for this grout was found at an old washing plant in the nearby area. This treatment resulted in walls having a uniform, pleasing greenish-grey color, which gave them added life and character.

Proper finishing of concrete walls requires skilled craftsmanship. This work on the Pentagon Building was supervised by a specialized finisher-foreman, originally brought to Washington to superintend the finish work on the National Airport structures (*see* ARCHITECTURAL CONCRETE, Vol. 8, No. 1). This foreman gained his experience under the writer on the West Coast where similar finish treatments have long been accepted as highly characteristic of exposed concrete.

nior structural engineer, USED, assistant general construction erintendent.

Naturally a project of this size presented problems in supervision. This vital work could be most successfully accomplished through the unified efforts of the contractor's superintendents and the government engineer-inspection force. Supervision, exercised jointly through the inspectors and superintendents, was necessary in order to cover the tremendous construction force, consisting at the peak of 16,000 men in all trades, working simultaneously in the many different areas of the vast building.

The contractor's main objective was production—cubic yards and more cubic yards had to be placed in order to stay on the progress schedule. Quantity was of first importance to him and his supervision was primarily to that end. The inspectors' supervision, on the other hand, was aimed at securing quality. Quantity and quality are two difficult factors to coordinate under such speed requirements—but under this joint responsibility for supervision it was found that quality constantly improved as the job progressed.

The concrete division of the inspection force was formed into a service pool for quick assignment wherever needed. Men were selected for their ability to cooperate. When the cry of "Concrete!" sounded, and the buggy rollers started their joy dance, the inspectors were always on the job. They were on the deck, down below on beams and columns, up above on wall forms—assisting the contractor in directing operations. Each inspector was assigned to an area and he stayed there until relieved or until placement operations were completed. He was specifically instructed in architectural concrete design, control and handling technique. He endeavored to have only concrete of proper quality delivered, and then directed its handling so the material was as properly placed and vibrated in the forms as conditions allowed.

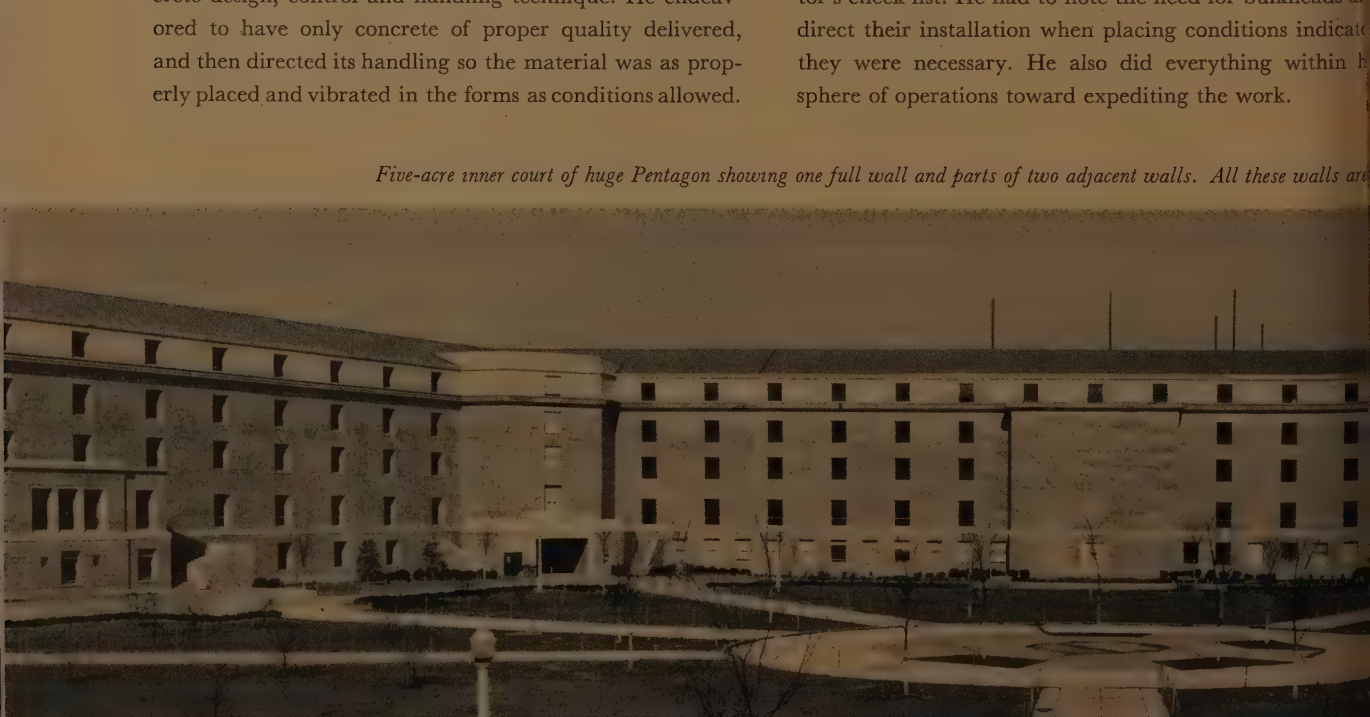




One of the five long sides f court and the ring walls district engineer. Genera

Special attention w directed to certain se tions of difficult or co plicated formwor Level constructio joints, full window sil alignment of form proper ties and brac and placement with minimum of honeycomb were items always on each inspe tor's check list. He had to note the need for bulkheads a direct their installation when placing conditions indicat they were necessary. He also did everything within h sphere of operations toward expediting the work.

Five-acre inner court of huge Pentagon showing one full wall and parts of two adjacent walls. All these walls ar





Pentagon Building, world's largest office structure. The exterior walls of this building are faced with stone. All other wall faces—of the inner hitectural concrete. The Pentagon Building was erected under the supervision of the Corps of Engineers, U. S. Army, Lieut. Col. Clarence Renshaw, firms of John McShain, Inc., Philadelphia; Doyle & Russell, and Wise Contracting Co.—both of Richmond, Va.

A major problem confronting the concrete department s to deliver sufficient material to satisfy the demand. ncrete was generally hoisted to deck hoppers and dis- buted in buggies. However, considerable horizontal trans- tation and some vertical lifting was done through pump es. Chuting and piping were kept to a minimum. There s no scarcity of labor—men were on the decks in ample mber. Many times decks and walls in different sections re placed simultaneously. On one day six different areas the project required a total of 3,669 cu.yd. of concrete. Various classes of concrete used were designed to give -day strengths of 2,000, 2,500, 3,750 and 4,000 p.s.i. ditional mixes were designed for high early strength, th for the building and for paving slabs and road work.

sand-cement grout.





A vigorous texture was produced for most exposed concrete wall surfaces by using rough-sawed form boards. The joints were emphasized by chamfering face edges of the boards to produce a bead. This is one of inner-court stairways.



Some impression of the size of the construction force is obtained from this view of several crews placing concrete for one of the floors while other crews in the background are placing concrete in exposed wall forms.



Mobile crane units and pump lines delivered thousands of yards of concrete for floors and ramps.

The building concrete was designed to have the prop consistency for placing with internal vibration without se regation. It had a surplus of cement paste to minimize t possibility of honeycomb, to give good bond to the reinforc ment and, above all, the desired surface texture. A m containing 5.7 sacks of portland cement per cu.yd. w used for most of the architectural work. It is felt that desig ing concrete primarily for strength in structures generall and for architectural concrete buildings specifically, is grave error. This concrete must have a high degree of wor ability. In having this, along with the required free cemen paste factor, it is not difficult to obtain the desired qualiti of strength, density and durability.

The water-cement ratio was accurately maintained, an test cylinders showed concrete of above specificatio strengths. During the winter months, vacuum mats we employed in placing all floor slabs. By removal of some the mixing water from the concrete in this way, hardenin was accelerated and the floor finishers were able to follo immediately after the placing operations were complete and the vacuum mats had been removed.

Sand and gravel were dredged from bars down river an aggregates were delivered directly to the mixing plant b tug and barge. The material was not always uniformly graded in that both fine and coarse materials seemed t vary with the river bar worked at the time. Flood cond tions also affected the grading of the aggregate. In orde to produce concrete with desired qualities, but still use th materials at hand, a flexible mix was set up for the genera 2,500-lb. class concrete. The proportions of sand to grav were made to run from a percentage ratio of 39:61 to 43:57 Plant inspectors were trained to adjust the mix with change in aggregate. Work was carried on with the principl in mind that the concrete in the forms was the real concret to be considered. The mix was designed with one eye on th

Placing roof slabs. The shallow pitch of the roof permitted dense concrete to be placed and vibrated on sloping roof without top forms.



ching plant and the other on the place of deposit.
When the "heat is on" and 20 or 30 transit-mix trucks are ling concrete, many variables enter into the operations. batching plant had the most modern weighing equip- nt. All mix weights were calculated on the basis of rated, surface-dry aggregates. Free moisture content of n aggregate was readily determined and was compen- d for in less time than it takes to explain the operation. s true in most large-scale work using transit-mix trucks, as not feasible to put all the water in the drum at the ching plant. Most of the water was weighed into the ms to assure control of the water-cement ratio but a ll measured quantity was put in the auxiliary tank on truck to be added by the truck operator at the place of osit to insure the mix being of the right consistency.





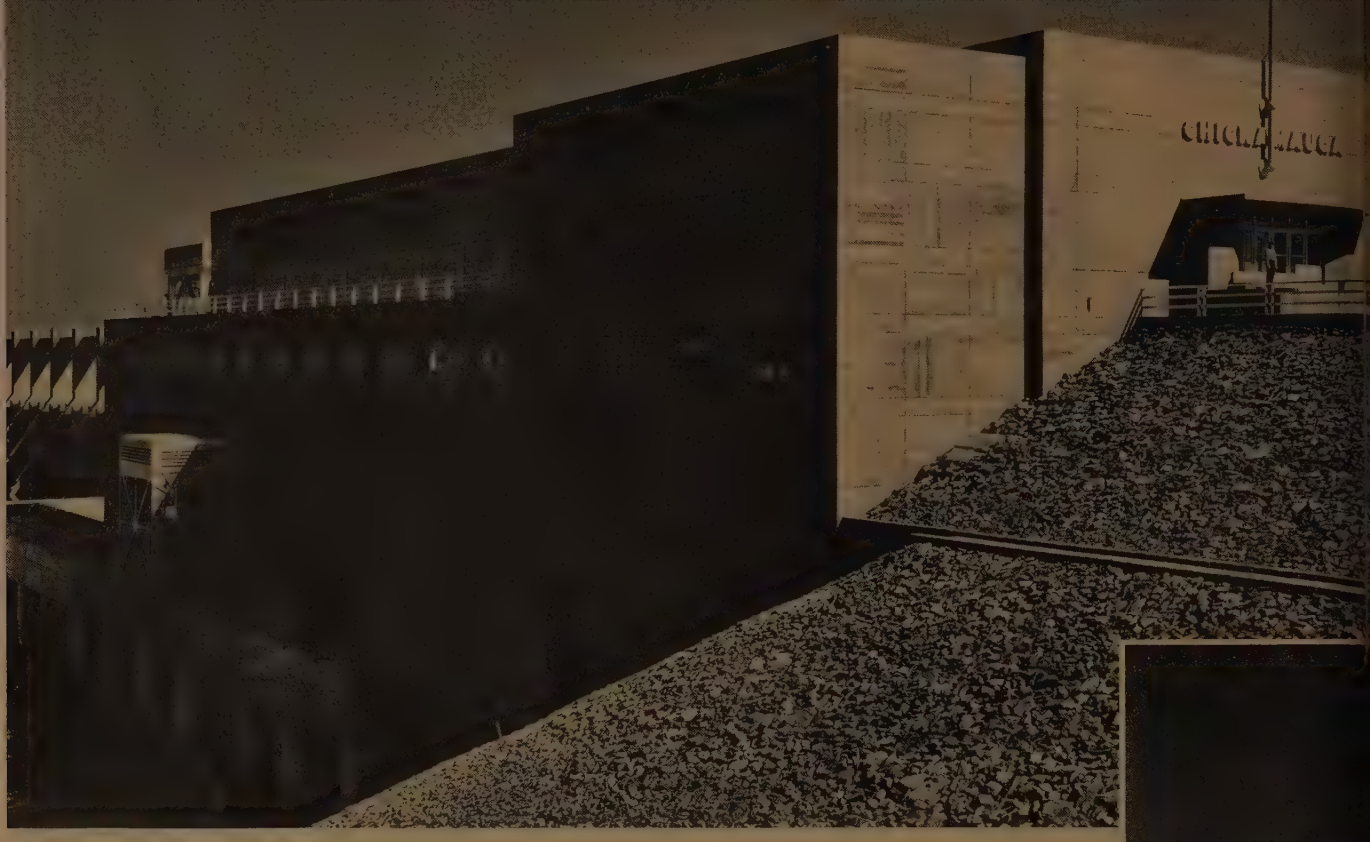
In cleaning the walls, the sand-cement grout was brushed on by finishers working on swinging scaffold. After the grout reached a certain degree of set, it was entirely wiped off with burlap, leaving a uniform color.

At each intersection of inner-court walls is a radial unit containing stairways. A truck opening in each radial unit connects the inner court with the outside.

erienced truck operators can tell the consistency of their l even before opening the discharge gate and they will only the required amount of water to give the slump red. Under rush conditions this method proved itself antageous in delivering a full-capacity load of the right lity concrete to the hoist hopper.

Work on this tremendous project has certainly con- uted much to the technique of "production line" con- ing—for construction operations continued steadily ugh good and bad weather and concreting went on and night under conditions that were sometimes most trying. The success of the project is a tribute to modern methods and to the enthusiastic cooperation of all superintendents, inspectors and workers in maintaining high standards of workmanship throughout the construction period.

The Pentagon Building was constructed under the direction of the Corps of Engineers, U. S. Army. General supervision and concrete control came under Lieut. Col. Clarence Renshaw, district engineer. His staff consisted of civilian and army engineers. The general contractors were the combined firms of John McShain, Inc., Philadelphia; Doyle & Russell, and Wise Contracting Co.—both of Richmond, Va.





Powerhouse at Chickamauga Dam. The long horizontal lines of the dam are carried through the powerhouse. Shades and shadows lend enchantment to this simple structure. (Right) Main entrance to powerhouse. The texture is provided by panels of rough-sawed form lumber separated by smooth-formed bands.

TVA—Ten Years of Concrete

By Harry B. Tour, A.I.A.*

(*Official TVA Photos*)

ON May 18, the Tennessee Valley Authority celebrated its tenth birthday. There was no party with cake and candles. The 40,000 employes spent the day speeding completion of huge masses of concrete and transforming our rushing rivers into speeding planes and roaring guns. There was little time to indulge in birthday reflections—but the significance of the 10 years of work did not escape anyone's thoughts.

By May 18, the TVA had emptied into its concrete mixers more than 10 million barrels of cement. And these millions of barrels of cement, binding the massive walls of huge power dams, are now helping to produce aluminum, nitrates, phosphates and other materials vitally needed by the United Nations in the conduct of the war.

The story of concrete and its relation to the war effo is no more interesting than the manner in which concre has been used architecturally in the Authority's powerhou structures. Working hand in hand, TVA architects and eng neers created designs which satisfied the requirements of t most enthusiastic functionalists but which did not sacrifi good taste on the altar of unrestrained functionalism. Fro the engineer's standpoint, these structures had to be d signed to permit rapid and economical construction. Th architects seized this opportunity to prove that these criteri instead of limiting the scope of their creations, actual provided the background for a new conception of moder architectural design.

*Principal architect, Design Department, Tennessee Valley Authority.

he flexibility of concrete lends itself to many uses and y adaptations. Beyond the intelligent solution of all ating and planning problems, the successful use of con- in architectural design depends upon the development leasing proportions, careful attention to shades and lows, and the surface texture of the material itself. Pro- ions and shadows are in a measure dependent upon the irement of the structure and practical construction ations. Surface treatment, on the contrary, reflects the and ingenuity of the designers.

description of three TVA projects can be used to illus- different techniques in the use of concrete for power- e superstructures. Each has proved successful in bring- o life the designer's conception of a building harmoniz- with its surroundings and integrated with the rest of the ect to form a unified and well-proportioned whole.



Chickamauga

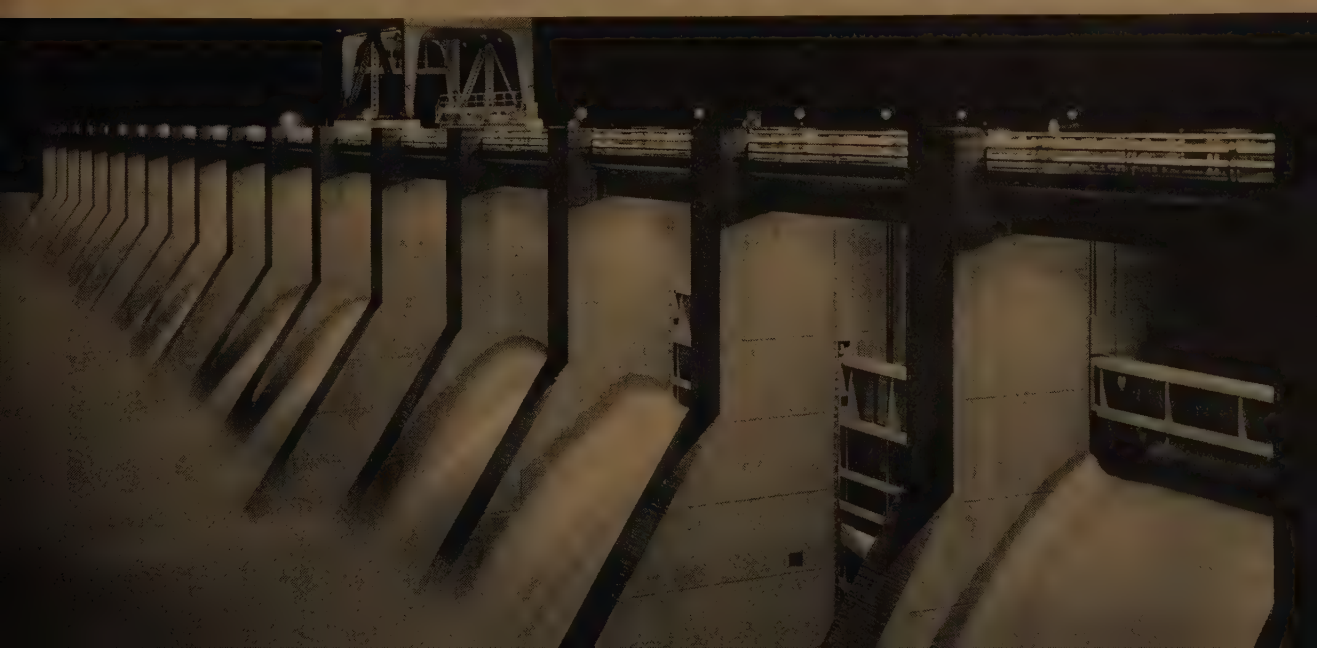
Typical of the low-head projects on the Tennessee River, the design of Chickamauga resolved itself into a long, low dam with the powerhouse forming a moderate extension of this barrier from the end of the spillway to the south bank of the river. The differential between the headwater of the lake and the level of the tailrace was such as to permit the economical use of a totally enclosed powerhouse with the highest part projecting only 28 ft. 6 in. above the top of the dam. This gave the architects and engineers a chance to develop a design which would carry the long, horizontal character of the dam through the massive masonry block of the powerhouse itself.

In the over-all design of the structure, three major factors influenced the general treatment of the exterior: (1) initial construction called for the installation of only three power generating units and provision had to be made for the future extension of the building to accommodate a fourth; (2) occasional floods, with their resulting periods of high tailwater, limited the location of openings and turned the lower part of the building into a watertight box; and (3) the probability of large numbers of visitors necessitated an enlargement of the south end of the building to provide adequate space for rest rooms and public accommodations. All of these criteria were met successfully by the simple expedient of mass composition and emphasis on strong horizontal lines.

Many devices have been used to create predominant lines in wall surfaces through the ingenious introduction of texture in the face of the material itself. Concrete, being a plastic material, lends itself to numerous possibilities, and because of this flexibility it is generally desirable to develop a textural effect which will conform to construction and economic limitations.

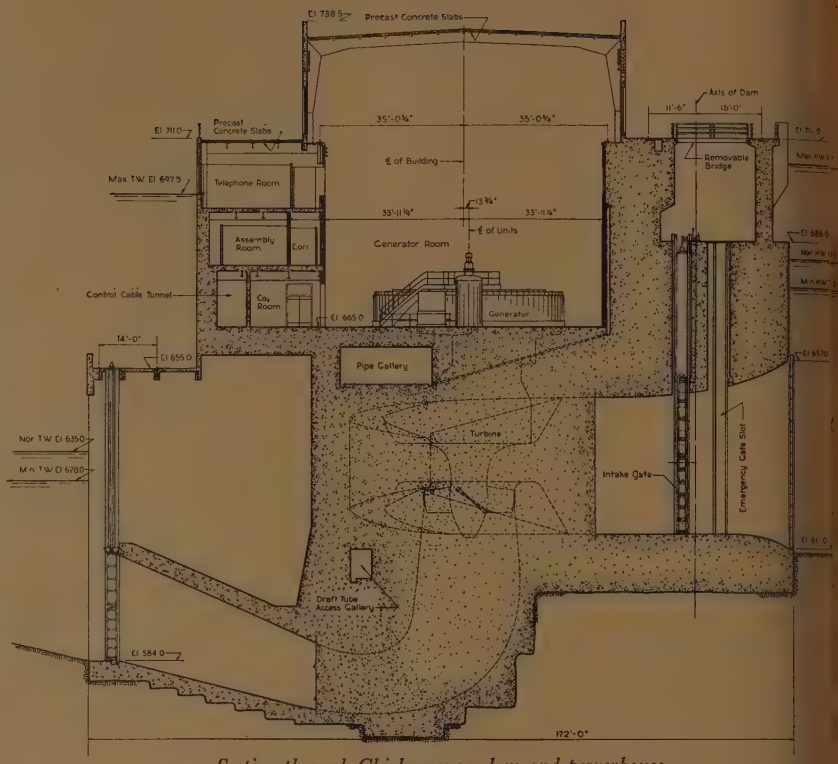
On the Chickamauga project, prefabricated panel forms were used extensively in the construction of the navigation lock. These forms were rigidly built of 3x10-in. studs, tied together with a steel channel along the top and an 8x8-in. wale across the bottom, and lagged with 1½-in. square-edge long-leaf yellow pine. For the sake of economy, it appeared

Spillway of Chickamauga Dam at night. Concealed lights under the bridge deck accent the man-made waterfalls.



desirable to adapt the treatment of the large flat wall areas on the powerhouse to the use of these panel forms. At the same time, some modification was essential to prevent, as far as possible, offsets and streaks in the wall surfaces caused by a spreading of the forms between lifts.

Walls were divided into rough bands approximately 5 ft. 6 in. wide separated by 2-ft. smooth stripes. For the main generator hall and reception area, concrete for the wider bands was placed against forms lined with nominal 6-in. wide T&G boards dressed on four sides with the grain horizontal. A variation was introduced in the walls of the electrical bay downstream, where the lining lumber for the 5-ft. 6-in. bands was cut with a coarse-tooth band saw. In areas where the rough-sawed forms were used, the direction of grain was alternated in adjacent panels.



Section through Chickamauga dam and powerhouse.

The 2-ft. stripes were made as smooth as possible in order to obtain maximum contrast with the wider bands. Forms for these narrow ribbons were lined with $\frac{3}{16}$-in. thick Presdwood, carefully nailed to the lagging to reduce the prominence of the nail heads. To prevent buckling, the Presdwood was soaked in water for 12 hours before it was nailed to the forms.

An ingenious method was devised to prevent grout leakage at the bottom of the forms. Sponge rubber gaskets, 2x$\frac{3}{8}$ in., were placed immediately below the bottom V-strips with the 2-in. side of the strip against the vertical surface of the wall to seal the joint between the form and the previously placed concrete. Final reports indicate that the cost of taking special care to obtain a neat finish was less than for the usual cleaning and patching which would have been required if this seal had not been used. Forms were left in place for 7 days to obviate water curing and thus eliminate streaking and discoloration of the finished surfaces.

Visitors' promenade, showing large areas of glass block and long alternating panels of rough- and smooth-texture panels. The large octagonal openings above the glass are ventilators for the generating rooms.



Although major emphasis was placed on horizontal lines, it was impossible to ignore vertical contraction joints which are essential to all large concrete structures. The contraction joints in the mass concrete substructure extend throughout the superstructure, dividing the building into four independent units. Continuous vertical joint markings were introduced at regular intervals between contraction joints with secondary V-grooves at intermediate points to provide flexibility in the location of construction joints.

Both horizontal and vertical joints were marked by $\frac{3}{4}$-in. deep by $1\frac{1}{2}$-in. wide V-grooves which formed a suitable separation between different types of formwork and, in addition, provided $\frac{3}{4}$-in. chamfers on all exposed edges. All bolts and form anchors were located within these V-grooves where subsequent patching would be less conspicuous.

Hiwassee

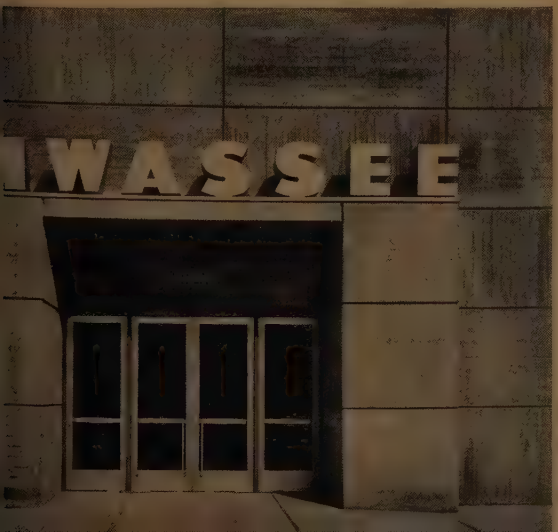
Where Chickamauga was typical of low-head dams on the main Tennes- River, Hiwassee is a good example the high-head projects on its tribu- ies. In the newer conception of archi- ture, the Hiwassee project embodies re than a monument to the skill of the igners and builders. It is a dynamic ce, transforming our natural resources o useful energy for winning the war. Unlike Chickamauga, the Hiwassee werhouse does not project above the n to form an important element in the dscape. Rather, it nestles into the dow of the huge concrete mass of the n itself, and by careful proportion l attention to detail, asserts its full nt to recognition.

Rather usual techniques characterize design and construction of the main werhouse structure. It is a semi-outdoor e, with the generators and other oper- ng equipment housed in a box-like ucture just below the level of the main k. Above the deck is the control build- , which contains control room, offices, eption room and visitors' rest rooms. s this control building which satisfies definition of architectural concrete. The shape of the building is pretty l defined by its function, the higher tion housing the control and recep- n rooms, and the lower section enclos-



At Hiwassee Dam, a high-head structure, the powerhouse nestles against the huge mass of the dam, yet asserts its right to recognition.

letters stand out in silhouette against the rough-textured back- e powerhouse walls which are large precast concrete blocks.



ing offices and other areas of lesser ceiling heights. Natural daylight being at a premium, a continuous band of glass block and sash around the office wing provides maximum light in these work areas and serves to break the monotony of the unrelieved wall areas of the rest of the building. Further interest is created by the introduction of a pronounced surface texture in the concrete as at Chickamauga.

In the stages of preliminary design, a great deal of thought was given to overcoming certain imperfections which may occur in the construction of concrete walls. Variation in density between the concrete at the top of one lift and the bottom of the lift above sometimes creates a marked contrast in color. Slight offsets in forms between lifts and grout leakage accentuate this contrast. These problems had to be overcome within the limits of a fast construction schedule.



Simple construction of forms made it possible to adopt mass production methods in casting the wall slabs. The forms were erected on a casting platform near the site. After casting, the blocks were cured with a fog spray of clean water.



Erecting the wall slabs. Two ¾-in. round rods were placed in horizontal and vertical keyways to provide reinforced concrete splines at all joints.



To achieve the block appearance on the roof of the powerhouse, which is visible from above, precast units were laid on pedestal blocks on the built-up roof.



Close-up of cylindrical pedestals. The roof squares were left with open joints to permit water to drain through to the built-up roofing covering the structural slab.



Powerhouse at Hiwassee under construction. A comparatively sma of scaffolding was used in setting the precast concrete blocks.

As a result of these considerations, the final design calle for the precasting of the concrete for the walls of the contr building and the erection of these precast slabs in a manne similar to that of cut stone. Details were developed to pro vide as much uniformity as possible in the size and shap of the slabs in order to minimize form costs and simplif the casting process.

A large floor was provided for the casting of the wa blocks. Forms, consisting of adjustable side walls for th edges of the slabs, were built in the carpenter shop an moved to the casting platform. Simple devices were devel oped for bolting these side boards together. After concreting the rough-sawed face lining boards were re placed with a new lining. Smooth board were resurfaced and reused.

Exterior surfaces of the precast blocks fo the main part of the control building wer formed with nominal 6-in. T&G well seasoned yellow pine, the face adjacent t the concrete being sawed with a coarse

r saw. Blocks for the main part of the building were so ed that the direction of grain in the form lining changed djacent blocks. Blocks for the sides and top of the main nce were formed with smooth lumber. Edges of the ks were chamfered with smooth-surface ¾-in. strips the tongue-and-groove lining was blind-nailed to the ng platform to conceal nail marks in the concrete.

he concrete contained 1½-in. maximum size aggregate between 1.50 and 1.55 bbl. of portland cement per d. and the water-cement ratio was 0.58 by weight. It stone. Blocks were moved into position by crane and adjusted into final alignment by means of two chain hoists attached to the structural steel frame. They were set in a full bed of mortar and held in place with wooden wedges until the mortar was hard enough to sustain the weight of the blocks.

To increase the stability and to make the joints absolutely watertight, keyways were provided around the edges of all blocks. At the time of setting, two ¾-in. round rods were placed in the double keyway of each horizontal and vertical



Daylight in the offices of the operating personnel is at a premium. A continuous band of glass block and sash provides as much light as possible for these rooms.

Cherokee Dam is another high-head structure with low-lying powerhouse. The walls of this building were cast against absorptive form lining.



compacted in the forms by means of flexible-shaft, nal electric vibrators, the vibrating elements being pped with rubber to prevent injury to the forms. The wall forms around the blocks were left on for at least ays before removal and the blocks were left in place the casting platform for at least 7 days before being ed to storage. Lifting inserts were cast in the back of blocks for lifting them into an upright position from the ing bed, and inserts were provided along the upper for moving the blocks into storage and handling them ng erection.

he blocks were moist-cured with filtered water to avoid ns which would have resulted from the use of silt-laden water. They were stored in a vertical position under vas and were kept moist for 21 days with air-water fog zles.

rection procedure was much like that used in setting



Spectacular view of Cherokee spillway from beneath the crane. The powerhouse, at left, has continuous sash to provide maximum illumination

joint and cement grout was forced in around the rods to form a reinforced concrete "spline". At the completion of the job the joints were raked to a depth of ¾ in. and pointed with elastic calking compound.

The roof of the Hiwassee control building likewise came in for its share of attention. The public highway crosses the dam directly above the powerhouse and the view from above is no less important than the appearance of the building at the operating deck level. To preserve the block-like character of the structure from above, square precast concrete deck slabs were laid on pedestal blocks over the entire roof area. The slabs themselves are 2 in. thick and rest directly on 10-in. diameter precast concrete cylinders. They are laid with open joints to permit water to find its way directly to the built-up roofing over the structural slab below.

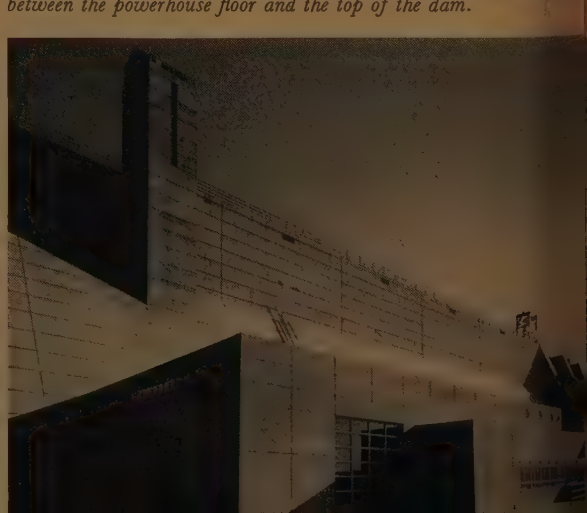
Cherokee

The Cherokee project was the first of the TVA power projects authorized by Congress on the emergency schedule to supply additional power for war production. Although it carries on the TVA tradition of excellence in design and construction, it will go down in history for a totally different reason. It is the first major project of its kind to be designed and built in the exceptionally short time of 15 months.

Cherokee is similar in many respects to Hiwassee. With a maximum head of 150 ft., the powerhouse appears small by comparison with the dam itself. But size alone is of little importance. Preservation of scale in a small, well-proportioned control building resting on the toe of a huge concrete wall is the criterion by which the adequacy of the design must be judged.

Functionally, the control building houses the visitors' reception facilities, the control room itself and the offices of the operating personnel. The topography did not allow enough space at the deck level for public parking, so this accommodation was located on a wide bench halfway up the north embankment.The result was a scheme of circu-

The lookout tower projecting above the dam houses an elevator which between the powerhouse floor and the top of the dam.



·for visitors which routes them down a set of outside to the control building, up the elevator to the top dam, and then back down to the parking area. Access elevator from the reception room was essential, and consequence the elevator tower assumed additional tectural significance.

nstruction methods resulting from a greatly accelerated ule did not permit the use of precast concrete wall s. The control building walls were designed in a con-nal manner with a block pattern of panels to accom-te construction and contraction joints. Details were fied in deference to the pressure of time.

ncurrently with the design of this project, test reports other areas were showing interesting results from the f absorptive form lining. Rapid removal of excess ure adjacent to the forms seemed to case-harden the e of the concrete to provide greater resistance to ion and to the penetration of moisture. The value of ecent development was especially significant on spill-urfaces where rushing water slowly but surely eats its into the concrete. But was its use justified on the ex-

terior wall surfaces of the control building?

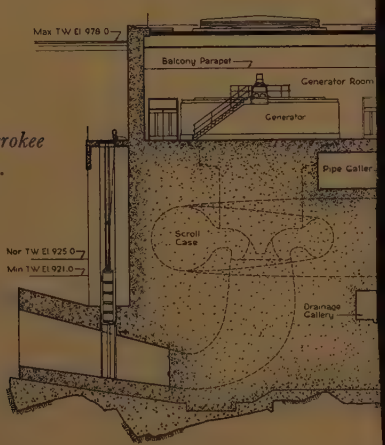
Studies were undertaken to determine whether staining and discoloration, which sometimes mar the beauty of concrete surfaces, might be remedied by the use of absorptive form linings. Favorable reports from the laboratory resulted in specifying its use on the Cherokee control building walls.

Prefabricated panel forms constructed for the powerhouse were remodeled to fit the small superstructure and were lined with absorptive material in sheets cut to the size of the wall blocks. V-joints, ½ in. deep by 1 in. wide, separated the panels and served as chamfers at the construction joints. Form anchors and tie rods were placed within the V-joints so that patches would not disfigure the uniformly-textured surface of the panels. During erection of the forms, care was exercised to keep the lining dry, and extra precautions were taken during placing to prevent damage from the vibrators.

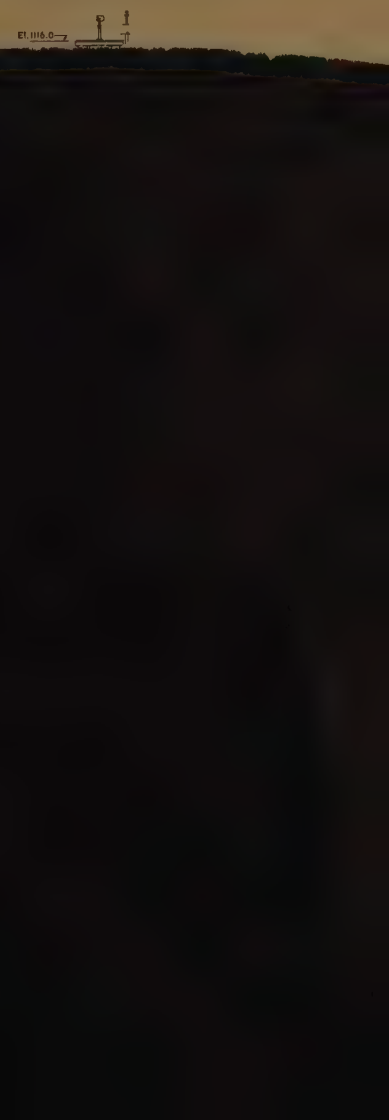
Time alone will judge the merits of absorptive form lining as a means of improving the quality of architectural concrete. Time, too, will judge the character of the architecture of the Tennessee Valley Authority as exemplified by Chickamauga, Hiwassee and Cherokee. As styles of living change, so styles and conceptions of architecture are modified to con-



btive form lining imparts a soft, uniform texture to the concr
ts, 1 in. wide and ½ in. deep, break the surface into cou
nceal the holes left by form anchors and tie rods.



n through Cherokee
nd powerhouse.





Concrete Buildings for Rock Island Arsenal

EDITOR'S NOTE:—All building construction described in this article was carried out at Rock Island Arsenal, Rock Island, Ill., under the administration of Brig. Gen. N. F. Ramsey, U. S. Army, commanding officer, and Col. Carl A. Waldmann, Ordnance Department, manufacturing officer.

(*Official U. S. Army Photos*)

A LARGE part of the military history of the Un States can be traced among the buildings and facil Rock Island Arsenal. Established in 1862 at the he the Civil War, it bears the marks of three past m flicts in the form of buildings erected in those time tional emergency to equip the U. S. Army. Now in dst of its fourth war, the Arsenal is building a new gr



stration building (left), built of architectural concrete, at land Arsenal, is a four-story e with two wings, one of nay be shut off during peace- Priester Construction Co., of port, Iowa, was contractor.

ctural interest is confined pri- to the entrance motif (left) where two massive pylons e on each side of the doorway.

al of Rock Island Arsenal is molded in the wall con- bove the entrance. A plaster mold made in the Arsenal's shop was built into the form luce this detail.

ructures, and these are of sizes and for purposes little med of in any of its past eras of intensive war pro- ion.

bout six weeks before the Arsenal celebrated its 80th day on July 11, 1942, the new administration building completed. This is a large office building, started in 1941, before the nation was at war, but at a time n it was known America would be the "arsenal of ocracy" and when plans for Rock Island Arsenal ex- ion had been under way for some time.

he administration building is an architectural concrete cture, four stories and basement, in the form of a huge The two large wings are 220x60 ft. each, and the con- ing and service section, containing the elevators, utili- and toilets, is 60x60 ft. The plan is so arranged that tional service sections may be added when necessary, hat the rear or north wing may be closed off entirely when peacetime brings a reduction in office space needs.

Walls of the building are smooth-formed against structural plywood panels. The panel forms were set in place with cranes in a manner illustrated by construction photos of another Arsenal building discussed in this article. Concrete was placed in comparatively low lifts—from below the first floor to the soffit of the spandrel beam and thence upward from window sills to window heads. Rustication lines effectively conceal all construction joints.

The concrete joist floors, averaging 10 plus 3 in. deep, were formed with removable metal pans and were designed for a live load of 100 p.s.f.

Working scaffolding was supported off the forms and all concrete was placed from the various floors as the construction progressed. Concrete from a central mixing plant was elevated to desired level by hoist and placed by means of concrete buggies. A combination of internal and external



Pan forms in place for first floor. Floors throughout the building are of this type, 10 plus 3 in. deep.



Administration building under construction. Well-constructed plywood panel forms were erected by crane, and concrete was placed in comparatively low lifts.

Side view of building showing ends of the two wings.



vibration was used, and great care w taken to prevent segregation of materi in the forms. This resulted in dense co crete walls with surfaces comparative free from blemish or honeycomb.

After each use the form panels we taken down, cleaned, oiled, and set up f the next lift. All forming material was th used five to six times.

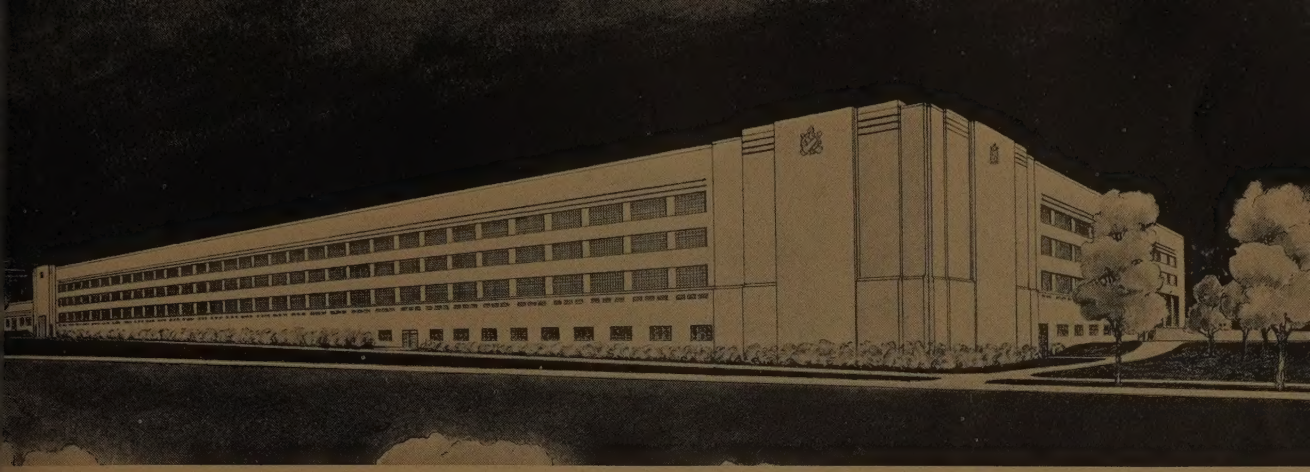
Expansion joints, located between ea wing and the connecting portion divide the building into three independent stru tures. Control joints were used generous throughout the building, being located centerlines of all window openings. I spections made at intervals following con pletion of the building indicate that the control joints are functioning as intende

The dominating feature of the buildin is the main entrance which is flanked b tall, massive, stepped-back pilasters an surmounted by a huge seal of the Arsena This device was cast in place in a plaste waste mold which was modeled in the Arse nal pattern shop. The detail is sharp an clean, reflecting the careful design an control of concrete used on this structure

After the walls were erected the exterio was given a clean-down treatment by th familiar means of applying cement grou with a float, scraping off excess materia and wiping the surfaces clean.

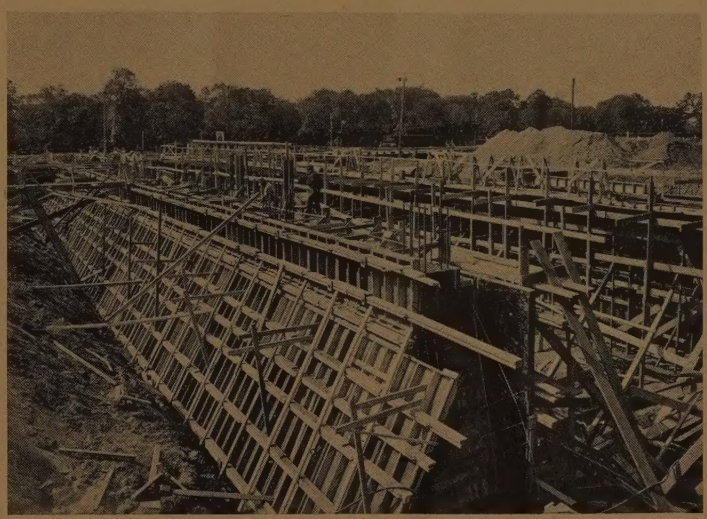
Inside the building the corridors ar finished with terrazzo. Some offices hav asphalt tile flooring while others utiliz the finished concrete surface. The ma jority of partitions are of cement-asbesto panels while wall finish varies—walnu panel board being used in the receptio room and some offices, marble slabs i main lobbies and first floor corridors, an glazed tiles in other corridors, stairwell and toilets. The majority of wall areas however, are not furred and the concret surface is finished with paint applie directly to the concrete.

The administration building was de signed by the Arsenal Plant Engineering Division and the Quartermaster Corps Sixth Construction Zone, Chicago, Ill and was built by the Priester Construction



ordnance building at the Arsenal is a long structure without movable windows. Walls are architectural concrete and glass block light bays.

Davenport, Iowa. Cost was approximately $938,000.
about the time the administration building was being
d over for use, work started on the heavy ordnance
ing designed by the Arsenal Plant Engineering
ion and the U. S. Engineers—a huge industrial struc-
810 ft. long and 300 ft. wide. It is divided into five
bays running the length of the building with a 60-ft.
bay at each end, each bay being served by two cranes.
city of the cranes varies from 5 to 20 tons, with crane
rs designed for a minimum of two 10-ton cranes.
addition to the main structure, a connecting building
existing building houses offices, medical aid station,
inside ramp and a dynamometer room complete with
e test cells.
ıen this building was started steel shortages were be-
ıg most acute and to eliminate as much critical metal
ssible in this construction, footings and foundations
built of mass concrete. Grading and foundation work
lone under a separate contract.
ncrete for footings, some of which are 20 ft. wide, for
lation walls and the floor was conveyed by pumping
a Pumpcrete machine. The floors are designed for
loadings—500-p.s.f. live load—and are mostly slab
l construction. One 240x280-ft. portion of the floor
e end of the building is a four-way flat slab over a
nent, and a corridor and a utilities tunnel running
ength of the building under two of the bays have a
ırly heavy floor design. Eight conveniently located
vells provide access to the toilet facilities and locker
s located below the main floor level.
terior walls are exceptionally high—48 ft. from first
level. These walls consist of 9-in. thick reinforced
ete between pilasters. There are no movable windows,
ination being through glass block and skylights.
rms for the walls were plywood panels set in place



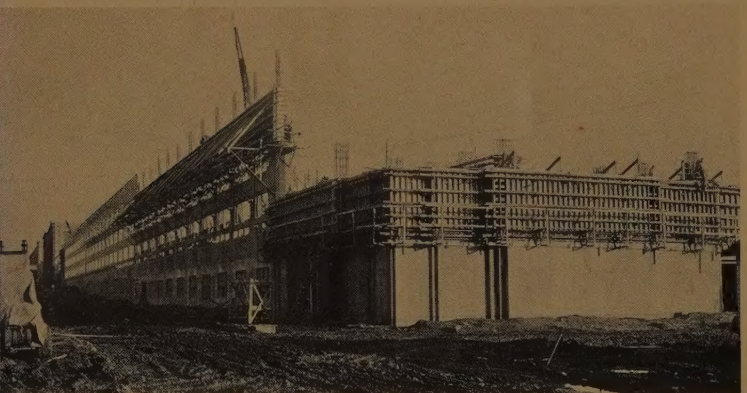
To save steel, footings and foundation walls were made of mass concrete. Reinforcement for walls of the superstructure extended into the foundation walls for anchorage.

Concrete for floors, footings and foundation walls was pumped into place. Grading and foundation work on the ordnance building were done by T. S. Willis, contractor, of Janesville, Wis.





Panel forms for the walls above grade were lifted into place by tractor crane.



Due to the great height of the wall and the absence of intermediate floors, forms were held in place and aligned by braces and struts supported on the lower part of the wall. Priester Construction Co., of Davenport, was contractor for all work above floor level.

with cranes. Concrete was placed with buckets special designed to control the rate of discharge. These bucke were hoisted into position by cranes and dumped direct into the forms. Lifts of concrete were kept to a minimur the highest being about 8 ft. Reinforcement for the wa was carried down into the substructure, with standa reinforcement used in walls from ground level up.

Columns in the exterior walls and in the rows betwe the five bays are arranged on 20-ft. centers. These colum support haunched crane girders. The columns were erecte up to base of crane rail and were provided with bracke to support the concrete crane girder. Shoring for the gird forms was assembled in units and erected in place b tractor cranes. Forms were then erected on the shorin which was wedged up into proper position, and the cra girder was cast continuously on the column brackets. Bo for the crane rail were cast in the top of the girder. Rei forcement in the form of loops from the brackets throug the stub of the columns was used to secure the crane girde to the column and prevent overturning.

After the crane girders were placed the columns we carried up to roof level, with brackets provided for t laminated wood roof girders.

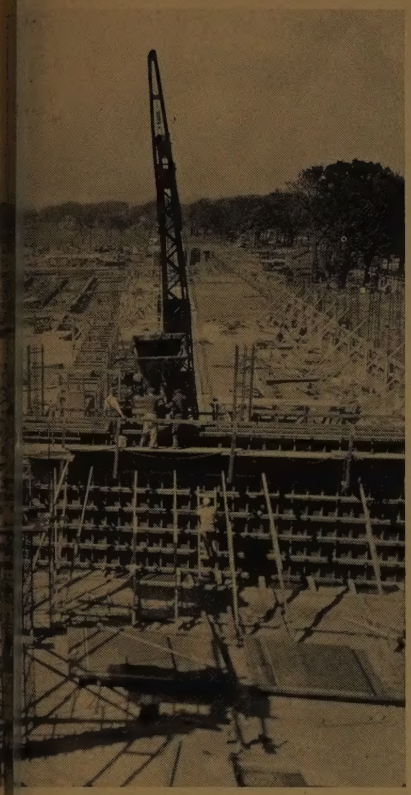
Shoring and forms for the crane girders were dismantle in units after each section was completed, and reassemble at other locations. Five or six reuses were thus possibl

Control joints are located in the center of every ba Corrugated glass skylights provide much of the interi illumination. Continuous ridge ventilators and wall louve provide ventilation for the building.

Since most of the work was done during winter month

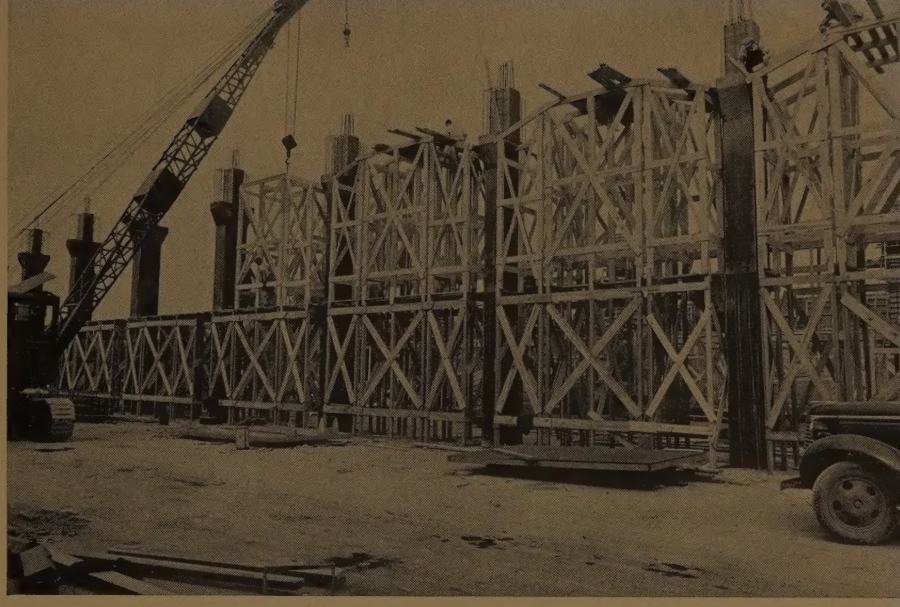
Interior of the heavy ordnance building is divided into five bays 60 ft. wide. Each bay is served by two cranes running on continuous haunched crane gir





blaced by buckets specially designed to control ischarge. They were hoisted by crane and t of deposit.

erable care was taken to prevent damage to the te. Concrete was mixed and placed at temperatures d 70 deg. F. Flax straw was then placed against the between the studs and wales to retain the heat of sh concrete. After concrete was in place, the top of lift was covered with tarpaulins. No other form of tion was used, but this was adequate. In several when outside temperatures had dropped below zero, f concrete under the straw and tarpaulin protection d it to be 80 deg. F. Temperature of the concrete from 56 to 80 deg. throughout winter construction.



Shoring for the crane girder forms was built in units and assembled by tractor crane. This photo, from left to right, shows various stages in erection of shoring and building girder forms.

Grading and substructure work on this project was done by T. S. Willis, contractor, of Janesville, Wis. The superstructure was built by Priester Construction Co.

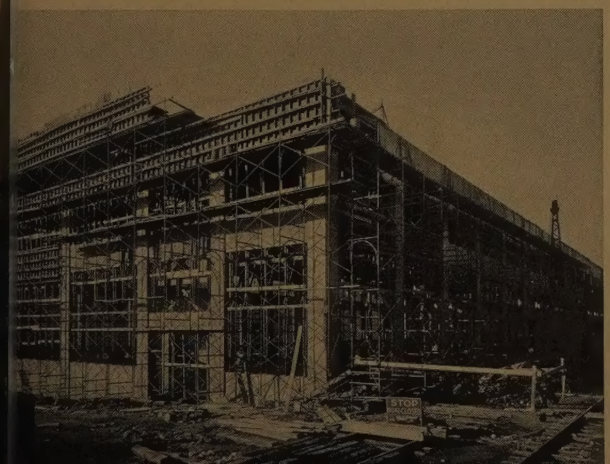
Another modern concrete structure at Rock Island, completed before either of the two buildings previously discussed here, is the heat treat and forge building. It is a steel frame building with concrete enclosing walls. Since it has comparatively high walls—36 ft.—and no intermediate floors, concrete was placed from steel scaffolding.

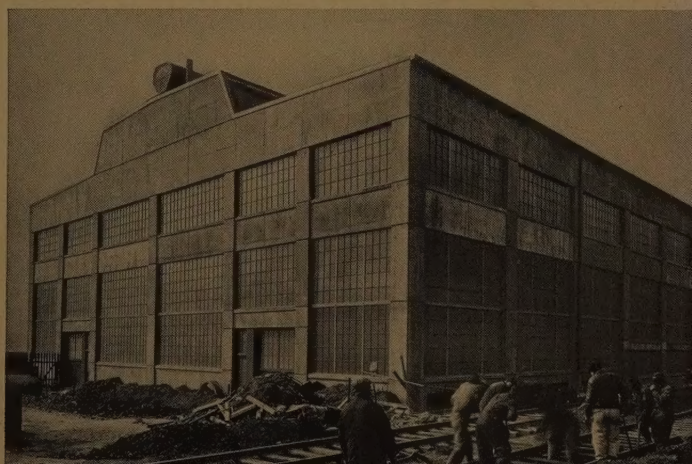
Plywood forms were used with rustications located at each construction joint. Concrete was placed with both internal and external vibration and excellent wall surfaces resulted. The walls remain as they came from the forms—without any cleaning or other finish treatment.

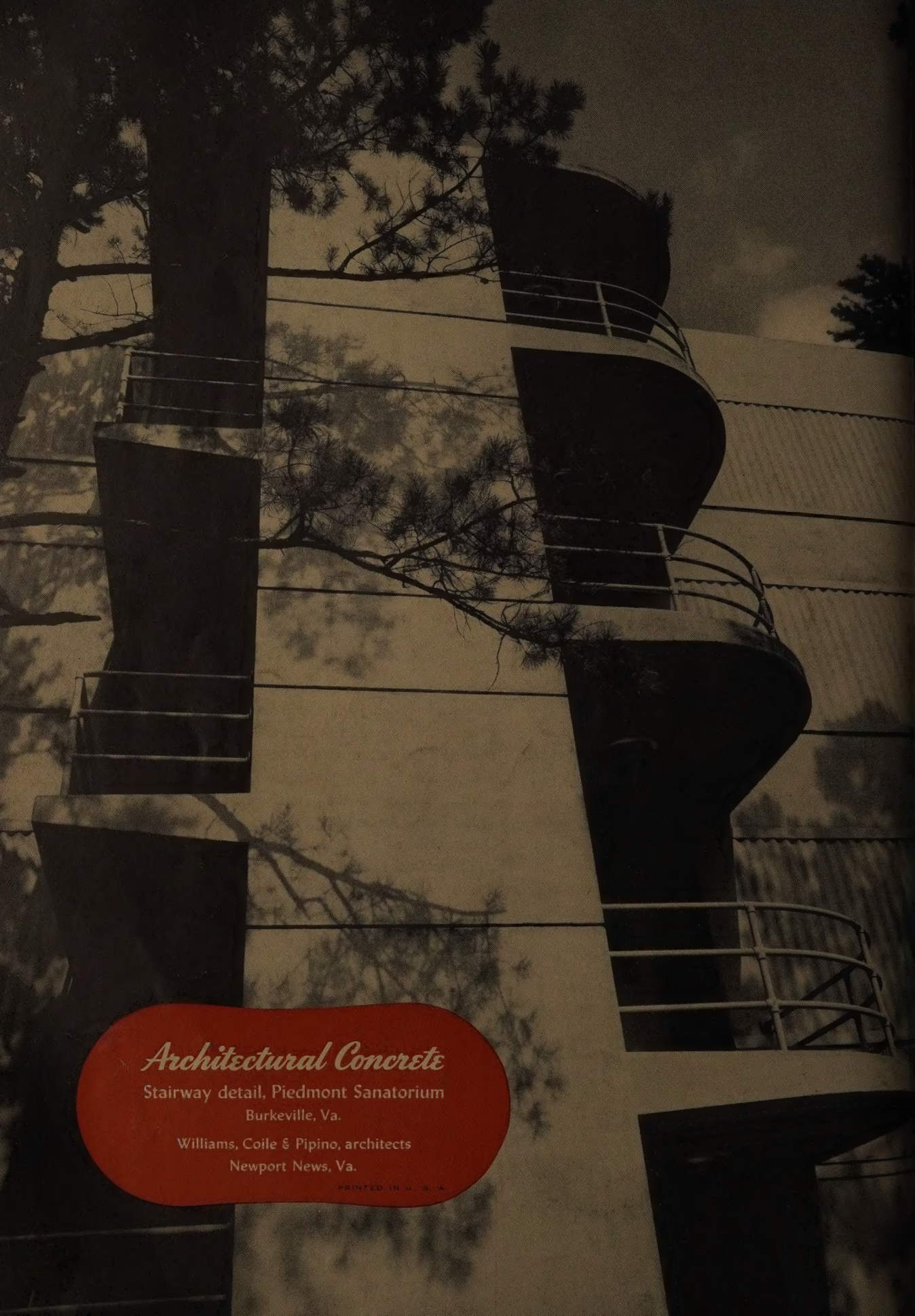
This building like the administration building was designed by the Arsenal Plant Engineering Division and the Quartermaster Corps, Construction Division, Washington, D. C., and was erected by Priester Construction Co.

Other new construction in concrete is going on at Rock Island which will be discussed at a later date.

as erected to facilitate building forms and placing concrete in the high walls of the heat treat and forge shop building. Well-designed concrete, vibrated y and externally in the forms, produced excellent surfaces which have never been cleaned nor given any other finish treatment.







Architectural Concrete

Stairway detail, Piedmont Sanatorium
Burkeville, Va.

Williams, Coile & Pipino, architects
Newport News, Va.

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